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THE CHAUTAUQUA TALKS.

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No. 2.

Talks about the Soil . . . . . By CHARLES BARNARD
(IN ACTIVE PREPARATION.)

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C. T. C. C.

TALKS ABOUT THE WEATHER

IN ITS RELATION TO

PLANTS AND ANIMALS.

A BOOK OF OBSERVATIONS FOR FARMERS, STUDENTS, AND SCHOOLS.

BY

CHARLES BARNARD,

AUTHOR OF "MY TEN-ROD FARM," "A SIMPLE FLOWER-GARDEN," "THE TONE-MASTERS," "KNIGHTS OF TO-DAY," "CO-OPERATION AS A BUSINESS," ETC.

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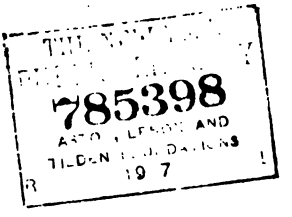

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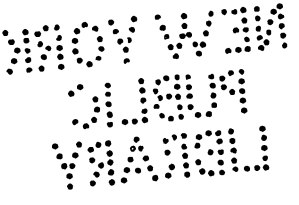


CONTENTS.

PAGE

PREFATORY NOTE v

INTRODUCTION x

CHAPTER I.

THE GROUND THE SOURCE OF WEALTH.

I. The Great Star. II. The Source of Wealth. III. The Great Industries 1–5

CHAPTER II.

THE SUN AND THE EARTH.

IV. Their Motions. V. Day and Night. VI. The Seasons. VII. The Heat of the Sun. VIII. The Chemical Effect of Sunlight 7–14

CHAPTER III.

THE ATMOSPHERE.

IX. The Atmosphere. X. The Thermometer. XI. The Temperature. XII. The Reflection of Heat: Its Absorption by the Air. XIII. "Forwarding." XIV. The Wind. XV. Air expanded by Heat. XVI. The Winds caused by the Sun. XVII. The Two Great Winds. XVIII. Shelter from Winds. XIX. Radiation of Heat from the Ground. XX. Value of Shelter. XXI. Mechanical Effects of the Wind 16–31

PAGE

CHAPTER IV.

CLIMATE.

XXII. Land and Water. XXIII. The Rain. XXIV. The Sun the Rain-mover. XXV. The Rainfall. XXVI. The Rain-gauge. XXVII. Climates. XXVIII. Weather Observations 41–52

CHAPTER V.

ARTIFICIAL CLIMATES.

XXIX. The Control of Temperature and Rainfall. XXX. The Cold-frame. XXXI. The Cold-grapery and Orchard-house. XXXII. The Hot-bed. XXXIII. Plant-houses. XXXIV. Practical Value of Observations. XXXV. The Two Roses, 62–80

CHAPTER VI.

CLIMATES AND PLANTS.

XXXVI. The Travels of the Seasons. XXXVII. The Grass-wave. XXXVIII. The Travelling Strawberry-crop. XXXIX. The Plants and the Seasons. XL. Some Plant-histories 86–95

CHAPTER VII.

PLANTS, CLIMATES, AND BUSINESS.

XLI. Our Great Farm. XLII. Plants Native to any Climate. XLIII. Plants and Business. XLIV. Early and Late Plants, or Double Crops. XLV. Crops in Succession. XLVI. The Useful Plants. XLVII. Conclusion . . . 100–120

PREFATORY NOTE.

HEADQUARTERS OF THE C. T. C. C.,
HOUGHTON FARM, MOUNTAINVILLE, ORANGE CO., N.Y.,
July, 1885.

THE Chautauqua Town and Country Club is a branch of the Chautauqua University, and is devoted to the practical study of plants and animals, horticulture and agriculture. Its course of instruction extends over a term of two years; and includes the observation and study of the weather, the growth and habits of plants and animals, practical work in the garden, the house, or upon the farm, and the reading of certain books. Every member on joining the Club receives a programme of work, and from this selects something to do during the summer months, under instructions sent by mail from the Club Headquarters. During each winter of the course, the members are required to read two books prepared specially for their use. This book is the first of the required readings for the first year of the class of 1887, and of all

classes formed in the future. It is to be read at some time during the first half of every term. In the spring of each year following the reading, examination-papers will be sent to every member of the club reading this book during that term; and to all those who answer eighty per cent of the questions correctly, and comply with other rules of the club, a diploma will be given by the Chautauqua University, upon the graduation of the class to which they belong.

As the C. T. C. C. is devoted to the practical study of plants and animals, and farm and garden work, particularly in their relation to business, this book is designed to show the sources of wealth, and to explain the influence of the weather upon our useful plants and animals. It is intended as a general introduction to the study of those things that immediately concern the health and well-being of plants and animals, — the sun, the motions of the earth, the temperature, the rain, the seasons and climates. It also includes a study of the relations of these things to business, and the actual making of money through the growth of plants and the care of animals. The book contains a great number of easy and interesting experiments and observations of the weather; and no one reading the book, whether a member of the

C. T. C. C. or not, should fail to make the observations and perform the experiments.

This book was prepared at the Club Headquarters, and all the reports of phenomena are from actual observations made by the chief of the experimental station at the farm. It was also prepared under the immediate supervision of Major Henry E. Alvord, manager of Houghton Farm.

THE AUTHOR.

For particulars concerning the C. T. C. C., and for application-blanks for membership, address Miss Kate F. Kimball, Plainfield, New Jersey.

TO THE MEMBERS OF THE CHAUTAUQUA TOWN AND COUNTRY CLUB.

THIS book, entitled "Talks about the Weather," is the first book of our course of readings. We all join in reading this book, at least once, at some time during the first year we are members of the Club. If you are a member of the class of 1887, you will please read it at some time between October, 1885, and June, 1886. If you are in the class of 1888, you read it a year later, or during the first winter of your term whenever it may be. You will see, that, to rightly study the book, there will be experiments and observations to be made. These you will find simple and easy, and most instructive. You cannot fail to learn something from every experiment; and many of them are well worth repeating many times, as an interesting accomplishment.

Your examination-papers will be sent to you when you have finished the reading of the book. The examination will include reports of the experiments; and you will find it important to perform all the experiments, and make all the observations, in order to easily and happily pass the examination.

To assist those who cannot easily obtain the thermometer and rain-gauge needed for the experiments, a cheap kit containing a good thermometer, gauge, and measure, will be sent by mail, postage paid, from headquarters, on the receipt of 85 cents; this being a special rate for the members of the Club only. Members living in towns can form local circles, and use one glass and gauge by lending the apparatus to each member of the circle in turn. If you do not know of any members in your neighborhood, write to headquarters; and the names of any others living near you will be sent to you, and you can join with them to form a circle.

Trusting you will find the book of interest and value, and that you will perform the experiments with success, and thus take one more step towards winning your diploma at graduation-day, I am

Sincerely your friend,

CHARLES BARNARD,

Superintendent of Instruction, C. T. C. C.

INTRODUCTION.

THERE lived at one time a man, who, being in want, and having long waited for Fortune, concluded that he would go in search of her. So he took what little money he had saved, shut up his house, and set out upon his travels in search of Fortune. He journeyed on for many days, and made diligent inquiry of those he met as to where Fortune might be found. Some said she was in one place, and some were quite sure she was in another place. All were certain she did not dwell with them, and many said that perhaps she might be found a little farther on. Several even said that she had been with them but lately, and had just gone away to another place. After travelling many leagues, and spending all his money, he sadly returned to his own home, and there found Fortune seated on his doorstep, as if waiting his return. As he drew near, she rose quickly, and said, —

"I have been waiting here for some time, in the hope that you would let me into your house. I have waited so long now, that I must go away to find others more ready to welcome me."

With these words she wrapped her mantle about her, and went away; and the man never saw her again.

This is only a fable, a story told a long time ago. There is many a fable that contains a grain of wisdom in a pretty wrapping. This old story is as good to-day as when it was first told; for it fits our times exactly, and is as wise to-day as ever. There are many people now, in town and country, who still think that Fortune must be living somewhere far away from their own homes; and, if they only knew which way to go, they would start to find her. When this man started on his journey, the general opinion was, that Fortune could be found in many places, — in the country, along the seashore, and in the towns. Now people will tell you that Fortune can be found only in cities.

Is this so? Where does Fortune live? Who knows how to find her? These are good questions, and well worth answering. In the first place, what do you mean by fortune? In the fable, Fortune is represented as a woman. Fortune, as we understand it, means wealth, food, clothing, houses, books, pictures, and all good things. Any one who has them, we say, is fortunate. Fortune may mean money; because money can be exchanged for food, clothing, shelter, and other good things. So it comes to this: Where can we go to get money? Where does wealth come from? Young men or women just starting in life see that many of those about them have money, and they wonder where they got it. If they ask others to give them money, every one says No. There does not seem to be any

money to spare. There must be new wealth somewhere. The people who have it refuse to give it up, except for work or food or some other good thing; and, at first, it seems as if all the wealth in the world had been already taken by some one, and there was none left for the young people. Does wealth grow in the cities? It is often said that such an one went to town, and made a fortune. How did he do it? where did he find it? He made it in the city. That is all that they say about it. "All the wealth is in the cities. You must go to the cities to find it." So every year hundreds of young men and women start towards the cities, in the hope that in some fashion they may find a fortune. A few do find it, or, rather, are already rich enough to buy it; but the others never find it, for the simple reason that they left it at home.

It is a good and worthy question: Where does wealth come from? What is the source of wealth? It must come from some place. It is plain, many people have found it. There must have been a time when there was very little, or none at all. We know, that, when the Pilgrims landed on Plymouth Rock, they brought very little with them, — only one small cargo to be divided among quite a large party. Now the Old Colony State is one of the richest in the Union. The settlers in all the colonies up and down the coast were poor people, and yet there are millions of wealth in the Atlantic States. California was once a poor place, without business or great cities or wealth: now it is a rich State. We are getting nearer to the

answer. The gold-mines. Plainly, California people have become rich because they dug gold out of the ground. In Pennsylvania, coal and iron are dug from the ground. Gold and iron and coal mean wealth. These hints point to the answer.

Wealth comes out of the ground. The only source of new wealth is the solid ground. But there are no gold or iron or coal mines in New England. Where did wealth come from there? Always from the ground. A portion also comes from the sea; but this, in one sense, is a part of the ground. By the ground is meant the earth, the planet on which we live. The ground includes the thin layer of soil spread over the rocks that form the solid globe; and the soil, though only a few inches deep, is the greatest source of wealth. Gold and silver, copper, iron, coal, diamonds, and pearls represent only a very small part of the wealth of the people of this country. There is food of every variety, clothing, houses, furniture, wood, plants, seeds, and animals of every kind; and these are also wealth. All of these come from the ground, and all from that part of the ground we call the soil. So it seems that the source of nearly all the wealth of the world is the soil. It is no wonder the man found Fortune at his door, when the chief source of fortune lay in the soil under his feet. This is the real meaning of the fable. Fortune does not reside far away in cities, but is everywhere under our feet, — on the farm, in the garden, on the mountains, on the prairies, in the valleys, in the streams, and in the great and

wide sea. There are only two places in the world where fortune cannot be found, — in the deserts, and in the streets of a city.

We must all have food to eat, clothing to protect us from heat and cold, and a roof for shelter from storms. It is wise and proper to search for these things diligently, and, having obtained them, to look earnestly for those other good things, — books, music, pictures, the society of good and pleasant people, and the means to make others happy. If we have wealth, we can purchase all good things. It is wise and right, therefore, to search for wealth, and to seek its source.

TALKS ABOUT THE WEATHER.

CHAPTER I.

THE GROUND THE SOURCE OF WEALTH.

I. **THE GREAT STAR.** — Far away in the great spaces beyond the clouds and the sky, more than ninety millions of miles from the place where we live, is a certain bright star. No man has been near it, no man is sure of what it is made. We only know it is of wondrous size, that it gives out light and heat, and that these things are of the utmost importance to every creature living here. We go out of doors, and look off over these ninety million miles of space; and its light is so bright that we cannot look upon it for more than a second. We feel the heat of its blazing fires upon our hands and face. We say it is a great star, and we call it the sun. We see the sun rise, and observe that birds, insects, and animals awake from sleep. We look closer, and observe that the dull and insensible plants also stir in a dumb, blind way, and turn to the sun, spread out their leaves and open their flowers towards its light. We obser-

that even the fish in the water come nearer to the surface, as if to seek the light. The dog and cat appear to enjoy the warmth of the sun, and will sit or lie for hours in the full light of this great star. If it is spring, we observe that the sun rises higher in the sky at every noon, and that both plants and animals appear to grow rapidly. In the fall, we observe that the light of this star grows less: it rises later, day by day, and all shadows at noon grow longer. Many plants and living creatures die; while other plants lose their leaves, and appear to sleep. Some of the birds disappear, and others change their plumage; and all animals are more warmly clad in fur and hair. Still later the light of the sun grows brighter, the days grow longer, and we say that the spring has returned. Again the plants revive; many kinds of birds and insects re-appear; flowers bloom and fruits ripen again. This observation plainly shows that this distant star we call the sun has an important influence over all plants and animals.

II. **THE SOURCE OF WEALTH.** — When we say that a person has wealth, we mean that he has certain valuable things, or that he has money with which he can buy these things. Now, these things may be land, or ships, houses, plants, seeds, animals, wood, fabrics, cotton, metals, minerals, or any thing else of value. If he has land, we say he has real property, or real estate. If he has any thing else, — plants, animals, seeds, minerals, or aught else, — we say he has personal property. We look closer into this matter,

and observe that all the personal property came from the real property.

Here is a man who owns some bales of cotton. They represent wealth. He can sell the cotton, and with the money buy food, clothing, or other things he may want. A few months ago he did not have this cotton. In fact, the cotton did not exist. Where, then, did he get it? All he had was some land and some seed. He put the seed in the ground; and in time it sprang up, and grew to be a bush having flowers. In time the flowers went to seed; and each seed appeared, wrapped in a lock of soft white cotton. The man gathered the seed and the cotton, separated one from the other, and put the cotton in bales. He now had new wealth, that a few months ago did not exist. He lost the seeds he placed in the ground, and he has now more seeds than before. Plainly, this new wealth represented by the seeds and cotton came from the ground. Another man has wheat or oats or barley, flax, potatoes, apples, or wood. He likewise had land, upon which grew the plants or trees from which these things came. They represent wealth, and all came directly from the ground.

Another man may have coal or iron; copper, silver, or other metals; stone, bricks, clay, pottery, oil, and slates. These also represent wealth, and they too came from the ground. Just here we observe a difference between these kinds of wealth. The man who dug the coal or copper or iron, or who quarried the slate and stones, or dug the clay which he used to make

bricks and pottery, may dig at any time: but when all the slate and stone are taken from the quarry, all the metals raised from the mine, all the oil pumped from the well, all the clay removed from the clay-pit, there is an end of the wealth; and, to find more, he must sink new wells and mines, and make new pits and quarries, in other places. On the other hand, the man who planted the seed, and raised from the ground wheat and flax, cotton, fruit, and roots, may do this continually on the same spot, or at least in the same farm, year after year. In this way he goes on making new wealth year by year; while the man who digs wealth from the rocks and hills may come to an end of his wealth, and have to look for it in another place. We shall observe, presently, when we come to examine this matter more closely, that this difference is caused in part by that great star we call the sun.

Another man has a flock of sheep; and in summer he cuts off their wool, which represents so much wealth. Here is a man who has a herd of cows that every day give him many quarts of milk, which he may sell for money. These men, at first, seem to have quite another method of getting wealth; but, if we observe the sheep and cows, we see that they must have grass and other plants to eat; and these come from the ground. So it is plain that the milk and wool also come indirectly from the soil. In this manner another class of things that may represent wealth comes indirectly from the ground. Among these we may include eggs, fowls, horses, sheep, cattle, pigs, leather, skins, butter, cheese, and many other things.

Another man has a boat-load of fresh fish. A few hours ago he had only a boat and a net. Where did this wealth that lies in the bottom of the boat come from? It also came indirectly from the ground, for many of these fish fed upon the water-plants that grow along the shore beneath the water.

III. **THE GREAT INDUSTRIES.** — Having observed that all this new wealth comes directly from real property, or from the ground, or the water, we see that it can be easily divided into three great classes. There are the minerals, the metals, the clays and stones, in one group; there are all the various fish in another group; there are the plants that grow in the ground, and the animals that feed upon these plants, and all the things obtained from these plants and animals. In like manner we may divide the men who obtain these things. There are the miners, whose work, under the general name of mining, may include the getting of minerals, metals, stones, and clay; there are the fishermen; and lastly, the plant-growers and animal-raisers, whom we call farmers, and whose work is included under the general name of farming. It is this that we are now to observe and study. We have already observed that the wealth obtained in agriculture comes first from the plants, and secondly from living creatures who feed upon plants. These plants come from the soil; but the moment we observe a living plant, we see that there are many things that affect the life of the plant. There is the rain, the wind, the air, the character of the soil, the seasons, and, most

important of all, the sun. We must therefore, first of all, observe this great star closely, to find out in what way it affects the life and growth of plants. Our first work must therefore be a careful observation of the sun.

CHAPTER II.

THE SUN AND THE EARTH.

IV. **THEIR MOTIONS.** — As soon as we begin to observe the sun, we find that it is subject to continual change. Select some clear evening, and a place where you can see the sun go down behind the hills and buildings, and make a note of, or try to remember, the precise spot where it disappeared. Do this every clear evening for two weeks. By the end of this time you will observe that the sun sets in a different place, to the right or left of the spot noted when the observations began. If the sunrise is observed, the place of rising will appear also to move to the right or left. Look at the clock when making each of these observations, and you will find that the sun also rises or sets a moment or so earlier or later each day.

Find some room where the shadow of the window-frame or the sash falls on the floor at exactly twelve o'clock in summer or winter, and make a mark on the floor. Six months later, examine the same shadow again at noon; and you will find it has moved, become shorter or longer. Another method of making this observation is, to take a strip of board a few inches wide and two feet long, and to set up at one end a

thin stick twelve inches long. Place this in the sun, at noon, on the first day of any month, and in such a position that the shadow of the stick will fall on the board. Measure the length of the shadow every day at noon for a month, or every day when the sun shines; and you will observe that the shadow slowly but steadily increases or diminishes day by day. If this experiment is tried in winter, the shadow will be shortest about the 21st of December; and, if tried in summer, the shadow will be longest about the 21st of June; and it will be travelling, between these dates, either one way or the other.

These observations prove to us that this great star is continually changing its path in the sky. When men first made these observations, they supposed that the sun actually moved across the sky, and that each day it took a new path, and that this caused these changes in the time and place of its rising and setting, and these changes in the length of shadows at noon. We now know that this travelling of the sun across the sky is only apparent. It seems to rise towards the highest point in the sky, it appears to have these varied paths, and it appears to go down in the west; yet it is really the earth on which we live that moves, and to its movements all these changes are due. We need not stop now to consider all this, because we wish only to observe the effects of these apparent changes in the sun, upon living plants and animals. It is sufficient to know that the earth turns round once in twenty-four hours, and presents different sides of the planet to

the sun in turn. The sun has its own motion upon its axis; but, as all sides are equally bright, this practically makes no difference in our observations, and we have only to observe now the effect of this turning of the earth every twenty-four hours. This motion of the planet divides the time into intervals of alternate light and darkness. If we are at any particular spot on the surface of the planet, it turns round, and brings us into the light; turns steadily on, and in time turns us away again into its own dark shadow. This motion gives us alternate light and darkness, day and night. The earth has also another motion. It moves around the sun once in a year, and, in sweeping over this great path, presents a different aspect to the sun, giving one portion a little more sunshine, and another portion a little less sunshine, at different times in the year. It is this motion that causes the changes in the shadows from month to month, and divides the year into seasons, — spring, summer, autumn, and winter.

V. **DAY AND NIGHT.** — We have observed that the time is divided, by the motion of the earth, into periods of light and darkness, day or night. Let us see what is the effect of day and night upon plants. We cannot try the experiment of placing a plant in the sun for twenty-four hours or longer; so, to study this matter, we must reverse the experiment, and see what would be the effect of taking away the sun for twenty-four hours or even longer. Take a healthy plant growing in a flower-pot, and place it in a dark closet. Give it water, and see that the closet is kept

warm. In a few days it appears to be injured. It turns white; and, if we leave it in the dark too long, it dies. If carried back to the sunlight, its blanched leaves quickly turn green; and, unless it has been kept too long in the dark, it will recover its health. In March or April we may sometimes find in a dark cellar an onion that has begun to grow, and has sent out slender white leaves. If left in the dark, it presently dies. Place it in a dish of water in a sunny window, and its blanched leaves soon turn green, and it begins to grow rapidly. These things show us that light is essential to the life and growth of plants. Naturally we might ask why it is not always day, why the sun does not always shine.

This leads us to quite another matter. A plant has life. It grows and lives; and, as we know of our own experience, all that lives has its periods of activity and rest, its times for growth and work and its times for rest and sleep. The time for growth and work is by day; for rest, by night. So it appears that this daily motion of our planet divides the perpetual light that streams from the sun, into nearly equal portions, leaving a space of darkness while half the earth rests in shadow, and thus maintains all plant and animal life in health and vigor. Outside of our earth it is always day; but, by the motion of the earth, every part of the earth once a day slides through the deep shadow of the planet.

We may observe one thing more in relation to this motion of the earth that gives us alternate day and

night. Plants and animals appear to wake from sleep as soon as it begins to be light in the morning, and to sleep again as soon as the sun disappears. They seem to wish to make the most of the daylight, and to sleep early to prepare for an early waking. So we find that those plants that have the full sun all day are more healthy and thrifty than those that receive the sun for only a part of the day. Plants in the shadow of a tree or house are less vigorous than those in the full sun all day. We must notice just here, that some plants prefer the shade, as the lily of the valley; but these are merely exceptions to the general law that all plants prefer the full sun, and for as long a time in the day as possible. This observation becomes of the utmost value when we wish to select a place for a garden, or a spot for a plant-house, or when we wish to choose a window for growing plants. This position of a plant or tree in regard to the sun, and the number of hours in the day in which it shall receive the sunshine, is called the aspect, or exposure. There are as many aspects as the points of the compass, and a very little observation will show that there is a difference in the value of these aspects. The aspect of any place is its relation to the sun; a south aspect being towards the south, or facing the sun at noon. The aspects stand in point of value in this order: south, south-east, south-west, east, west, north-east, north-west, north. A plant with a south exposure receives the sun all day, from its rising to its setting. A plant with a south-east aspect has it all day, except at

the very end of the day. Here another curious thing appears. It seems to be the result of many observations made at different times by different people, that the morning sunlight is more beneficial to a plant than the afternoon sunlight. In the morning the plant, like the animal, is refreshed by rest, and is active and vigorous. In the afternoon it is already preparing for rest. Its force is partly spent, and the sunlight appears to have less effect upon it. So we find that next to the south aspect is the east aspect. South-east is between the two. South-west is next in value; and if the plant is to be shaded from the sun at either end of the day, it will be best to face the east. North, north-east, and north-west aspects are to be avoided, as the least sun is received; and the northern side of a building in the shade is wholly unsuited for the growth of plants. Such an aspect is useful only when we wish plants to rest, and to merely live without growing.

VI. **THE SEASONS.** — Our observations have shown us that the position of the sun at noon, the hour of sunrise and sunset, and the length of the day, are continually changing. These changes are the result of the yearly motion of the earth; and this motion, like the daily motion, has a visible effect upon the life and growth of all plants. These slow changes in the apparent path of the sun in the sky mark the changes of the seasons. Our observations of the sun will show us that one-half the year the days are growing longer, and the other half they are growing shorter.

Looking at plants out of doors, we observe that all are growing rapidly while the days are increasing in length, and that they grow less rapidly, or cease to grow at all, during that part of the year when the days are decreasing in length. These observations show that this motion of the earth, governing the length of the day, and the amount of sunlight, also indirectly governs the growth of plants. These facts, obtained from observations of the sun and earth, make the foundations of all work with plants and animals. They govern the work of raising and caring for plants; and, as plants form one of the great sources of wealth, we see that the relations of the great star that gives us light, to the planet on which we live, directly control the production of wealth. These motions mark the days and the seasons, and all work in agriculture must be governed by the changing seasons and the alternating days and nights.

VII. **THE HEAT OF THE SUN.** — So far we have observed the sun only as a source of light, and the motions of the earth as dividing the amount of light into unequal portions according to the seasons. We may now consider the heat of the sun as separate from its light. A little consideration will show that we have found that the heat of the sun is greater in summer than in winter, that it is much greater on certain days in any season than other days perhaps in the same week. The amount of heat given by the sun varies continually every day, and from hour to hour during the day. It is less at early morning than at noon,

increasing steadily from sunrise till about three o'clock in the afternoon, when it begins to rapidly diminish. Though the heat of the sun appears to vary from day to day, it steadily increases through the spring, and diminishes through the fall. It has been found that plants growing in spring demand more and more heat, and in the fall require less and less heat; and this corresponds precisely to the changes in the heat of the sun during these seasons. A plant is more active in the morning, and the heat increases. It is exhausted and inclined to rest towards night, and the heat diminishes. It demands more and more heat while growing in spring, and the heat increases as the season advances. It requires less and less heat as it ceases to grow, and prepares for its long rest in winter; and the heat steadily diminishes through the fall.

VIII. **THE CHEMICAL EFFECT OF SUNLIGHT.** — There is besides the light from the sun, besides the heat that accompanies the light, another feature of sunlight that materially affects the life and health of all plants. This is called the chemical effect of light. It is not so evident, at first sight, as the effect of light or heat; yet it is plainly shown in the experiment we tried with the onion. In the dark cellar, the onion sent out its shoots quite blanched and white. When it was brought into the sunlight, the leaves turned green. They also became tougher and stronger. This changing of the color of a plant illustrates the chemical effects of the light; and it is quite different from the heat of sunlight and the actual light, because

it has been found, in certain experiments with light, that rays from the sun that are cold, or quite dark, still produce chemical effects. The fading of colors in cloths kept in the sunlight is a chemical effect of light. The art of photography is founded wholly on the chemical effects of light. In plants this chemical effect of light is made of use by causing plants to grow in the shade or in total darkness, or in causing one part of a plant to be in sunshine and another part in the dark. This is shown in the cabbage and lettuce plants. The habit of these plants is to curl their leaves inward, one over the other, and to cover the centre of the plant. The centre, growing in the dark, then becomes white, brittle, and succulent, making it fit to be eaten raw. Celery (and sometimes rhubarb) is also treated in this way: the stems of the plants are shaded or covered; and, in growing, they remain white and brittle, and have a flavor they would not give if left to grow in the full sunshine. The colors of flowers and fruit also result from the chemical rays from the sun. The colors may also be caused in part by the heat of the sun. How far the chemical rays color the rose and apple, we cannot tell: yet we must recognize that all plants grown in the dark are white and colorless; and the same thing undoubtedly applies to the flowers and fruits. At the same time it must be observed, that fruits are highly colored while growing in partial shade, provided the leaves of the plant are in the sun. This is shown in the grape-vine, particularly when under glass.

CHAPTER III.

THE ATMOSPHERE.

IX. **THE ATMOSPHERE.** — One of the first things we notice in making these observations of the heat and light of the sun, is that they both vary greatly from hour to hour through the day. We observe that the heat and light do not increase or decrease together. We find cold bright days in winter, and warm dark days in summer. The amount of light may remain the same all day, and yet the heat of the sun will appear to change greatly. Besides this we find that the heat changes during the night; sometimes increasing, and sometimes diminishing, while it is quite dark.

X. **THE THERMOMETER.** — So far we have made our observations without the aid of any instruments, except a clock to observe the time of sunrise and sunset. We must now make more careful and accurate observations; and, in order to study the sun and its effects upon plants, we need a thermometer. A good thermometer can be bought for fifty cents, and a fair one for about thirty-five cents. The best plan is to get as good a one as can be afforded. The better the tools, the better the work. We are now approaching

the study of science as applied to plants and animals, and we shall find that at the very foundation of successful work in the care of plants and animals is the habit of close and accurate observation. One of the most important things to observe is the temperature. By this is meant the temperature of the air. To take up this study, we must have a thermometer; and this should now be procured. Choose a metal thermometer, or one on which the figures are marked on metal, and not on wood or paper, or, better still, one marked on the glass tube. All the references to the thermometer here mean one marked on the Fahrenheit scale, and all references mean this scale; as, seventy-five means seventy-five degrees Fahrenheit, or seventy-five Fahrenheit.

XI. **THE TEMPERATURE.** — Place the glass (by which is now always meant the thermometer) in the full sun in a window. It will rise rapidly, and touch (in April) 100°. Now open the window, and put the glass in the full sunlight. At once it begins to fall, and, in a few minutes, sinks to 82° or thereabouts. Here is a difference between the outside and inside of a window, in the full sun, of eighteen degrees. Clearly, there is no difference in the sunlight in this time. The heat of the sun's rays have not fallen so much in such a short time. We must look elsewhere to find the cause of this remarkable change in the glass. This difference between the height of the glass in the house and out of doors depends upon the air. The atmosphere surrounds the whole earth, and all plants and

animals on its surface live in it. The air is easily warmed by heat from a fire or from the sun. It will also easily part with its heat, as is shown by the rapid cooling of the air at night, or when the sun is obscured by a cloud. Now, in considering these matters, we will hereafter understand that the temperature means the heat of the air at any time. A high temperature means that the air is warm: a low temperature means that the air is cold. To find the temperature at any time, we must place the glass out of doors, not in the sun (which would give the heat of the sun's rays), but in the shade; and the glass will indicate the temperature of the air close about it, or very nearly the general temperature of the atmosphere near it. It will indicate the amount of heat taken up by the air at that time.

XII. **THE REFLECTION OF HEAT: ITS ABSORPTION BY THE AIR.** — The sun's rays passing through the air strike upon the ground, the water, the rocks, grass, buildings, or other objects, and they become heated; and this heat is in turn imparted or reflected into the air, raising its temperature. Place the glass in the shade of a board, a tree, or other object casting a small shadow, and close to the south side of a board fence, wall, or building. Observe the temperature: then carry the glass a short distance to an open field or yard, and again place it in the shade of some small object. A decided fall in the glass will be observed. This observation clearly shows that the temperature is higher near the sunny

wall or building. The air is warmed by the reflected heat from the building, fence, or wall. There being less reflection from the level ground in the open field, the temperature is less.

Another important element must here be considered. The air next the building may be quiet and at rest. In the field it may be steadily moving away. Get a small wooden box without a cover. Place it in the sunlight out of doors. Put the thermometer inside, at the front, in the shade of the side of the box. Now cover the top of the box with a sheet of glass or oiled paper, or even thin cotton cloth. Look at the glass when the experiment begins, to see the temperature outside the box and inside the box. Let the box rest in the sun for twenty minutes, and then look at the glass. The inside of the box will be quite warm, and the glass will indicate a decided rise in the temperature. This experiment can also be performed by placing the glass (in the shade) in a cold-frame (not a hot-bed) or in a greenhouse, or in a sunny room where there is no fire. In each case the temperature is higher than out of doors at the same time. This experiment serves to show, that if a body of air is kept at rest, by confinement in a box, or frame, or building having glass sides or windows, it will take up more and more heat as long as the sunlight lasts. Take off the cover of the box or the frame, open the doors and windows of the house, and leave the air free to move away; and the air inside will no longer increase in temperature. This partly explains why the tempera-

ture is higher on the south side of a building when the wind is north. The building prevents the air from moving away; and it takes up more and more heat, reflected from the walls warmed by the sun. This also explains our experiment with the glass in the sun, inside and outside the window.

XIII. "**FORWARDING**."—These observations lead to important and valuable information in regard to the care of plants and animals. It may seem of little use to go about with a thermometer, testing the temperature of the air in these different places. Experiments often seem of no value, because we do not know how to use what the experiments show. If some one tells us how to have green pease or rhubarb a week before our neighbors, we call him a very smart gardener, and perhaps wonder where he learned such a valuable secret. If some one else tells us how he succeeds in having such thrifty chickens so early in the season, or how it happens his cows look so well, and give so much milk, we regard the man as a good farmer or poultryman, and wonder where he learned so much about such matters. This art of raising early vegetables and flowers is called by the gardeners "forwarding." We say the gardener knows how to "forward," or hurry up, his crops, and cause them to be ready for use early in the spring or summer. At the same time our experiments have been telling us the very secret of "forwarding" plants, and having healthy and profitable cows and poultry. If we have found, that, on the south side of a fence or building, the temperature is higher

than in an open field, clearly such a place must be best for early plants like peas, lettuce, or rhubarb, or early flowers like the snowdrop, hyacinth, or jonquil. Our experiments have shown that the temperature is raised by reflection from a wall or building, and by the shelter from the wind. The air being kept in one place stores up the heat: the ground also becomes warmer, because the air above it is not continually moving away, and carrying off the heat imparted by the sun. In the frame, or the greenhouse, or sunny room, early plants like tomatoes, lettuce, cabbages, and many kinds of flowering plants, can be made to grow in the heat stored up by the air confined in such places. So it comes, that, by the intelligent use of the facts we discovered in our experiments, we learn to hasten, or "forward," our plants. Our experiments tell the gardener's secret. He, and his fathers before him, found these things out after many long years of trial with different plants in different places. We learn the secret in an hour, by a simple experiment with a thermometer, added to a little common-sense to make our science useful. Perhaps we see now why the farmer puts his cows out in the sunny yard in winter, where they will be warmed by the sunlight, and yet protected from the wind by a shed or building that serves to keep the air from moving, and allows it to become heated. If he had driven his cows out into an open field, he would soon find that it made a wonderful difference in their health, and consequently in their supply of good milk. We see now why the good poultry-man

has large windows on the south side of his buildings. The cold-grapery and the cold-frame, a hillside, a fence, or even boards set up on edge behind a row of pease, all serve to raise the temperature, partly by reflection of the heat of the sun, and partly by confining the air and causing it to store up the heat; and all are used to hasten, or "forward," plants and flowers, and to add to the health and comfort of birds and animals.

XIV. **THE WIND.** — Get a stout pole eight or ten feet long (a hop or bean pole), and set it up firmly in the ground in a field, or in some open place away from buildings. Find the points of the compass at the pole, and place on the ground white stones or wooden stakes, or something else that will show the points of the compass easily. To the top of the pole tie a strip of light white muslin or cotton, about a yard long. Drive a nail in the pole, on which the thermometer can be hung, where it can be easily seen. Hang up the glass on the pole every night at sundown, for not less than fourteen consecutive nights. At nine o'clock go to the pole with a lantern (in all weathers, rain or shine), and find out, from the flag or streamer, the direction of the wind, and, at the same time, the height of the glass. Make a record of the direction of the wind, — whether it is east, north, west, or south, or north-east, south-east, north-west, or south-west, — and the height of the glass, as soon as you return to the house. If not convenient to do this, hang the glass outside the window, where it can be easily seen

by taking a lamp to the window. Observe by a weather-vane the direction of the wind at dusk, or as late in the twilight as possible. Observe the height of the glass at nine o'clock, taking pains to open the window to see by the air stirring that the wind has not changed since dark. (This will seldom occur.) Make a record of the wind and the glass every night, for fourteen consecutive nights. If the glass is used on the pole in a field, take it in after the observation has been made.

Before making these observations, notice the conditions of our work. The sun has gone, and its heat does not directly affect our thermometer. To prove this, we have only to look at the glass just before sunset, and again at nine o'clock; and we shall find that sometimes it falls many degrees, while at other times it stands quite still, or sinks only one or two degrees. It may even rise, and be higher at nine o'clock at night than at any time during the previous day when the sun was shining. There is evidently some other cause affecting the glass. This we wish to find out. Notice one thing more. The atmosphere is seldom at rest. It is rarely perfectly calm; and this motion, which we call the wind, tends to move all the air away, so that really our glass out on the pole is constantly subjected to fresh currents of air that come to it from every direction. It is precisely as if it stood in a river of air that is continually flowing past. The direction *from* which the whole mass of the atmosphere seems to reach the glass, we call the direction of the

wind. If it comes from the south, we call it a south wind; from the north, a north wind, and so on: and, in taking an observation of the wind with the pennant on the pole, the head, or end of the pennant next the pole, points to the point of compass that gives a name to the wind. In other words, our streamer, like the tail-end of a weather-vane, points away from the wind; and, if this is east, the wind is west, and so on.

Having noticed these things, we begin our observations, and keep them up for not less than fourteen consecutive nights, making a record of the wind and the height of the glass each time. At the end of our observations we will study our record to see what we may learn from it.

To assist in understanding this matter, here is an actual record of the wind, and the height of the thermometer, taken at nine P.M. at Houghton Farm, for the first fourteen days in May, 1885: —

Date.	Temperature.	Direction of Wind.	Amount of Wind.
1	41	N.E.	Moderate.
2	43	N.	Moderate.
3	40	E.	Very light.
4	44	W.	Very light.
5	50	S.	Strong.
6	50	N.	Moderate.
7	51	Calm.	Calm.
8	42	N.	Moderate.
9	43	S.E.	Light.
10	48	Calm.	Calm.
11	44	S.W.	Light.
12	53	S.W.	Moderate.
13	51	N.E.	Very light.
14	58	W.	Moderate.

REPORT OF WIND, TEMPERATURE, AND CLOUDS, TAKEN AT 9 P.M. AT HOUGHTON FARM, IN FEBRUARY, 1885.

Date.	Temperature.	Wind.	Amount.	Clouds.
1	17	N.W.	Moderate.	Clear.
2	6	N.E.	Very light.	Fair.
3	15	N.E.	Very light.	Cloudy.
4	26	Calm.	Calm.	Cloudy.
5	24	N.	Very light.	Cloudy.
6	6	N.E.	Very light.	Clear.
7	6	N.	Very light.	Clear.
8	16	N.	Very light.	Clear.
9	35	S.E.	Moderate.	Cloudy.
10	13	N.	Very light.	Clear.
11	2	S.W.	Moderate.	Clear.
12	18	S.W.	Moderate.	Clear.
13	12	N.E.	Very light.	Cloudy.
14	17	Calm.	Calm.	Clear.

In this report, the state of the clouds is added to illustrate another matter later on. Taking the first report, we find the first four days with very little change; the winds being northerly, the highest temperature being with a west wind. On the fifth day a strong south wind raises the temperature at once. It remains high with a north wind on the following nights; but the wind is moderate, or it is calm, till the eighth day, when it falls again; and it is not till the ninth that the temperature decidedly rises with south-east wind.

The tenth is calm; and on the eleventh and twelfth the south wind again blows, and the temperature rises, and remains high, though slightly depressed with the north-east wind on the thirteenth, the west wind sending it up again. At first there appear to be contradictions in this record. It is just as warm on the sixth with a north wind, as on the night before; but it will be observed that the north wind is light, while the south wind was strong. The temperature was raised by the strong south wind, and it did not fall under the influence of the moderate north wind. On the eighth, after the calm of the night before, it falls decidedly.

In the February report, though it is winter, the changes in temperature are even more marked. There is an apparent contradiction in this report when we see the fall in temperature on the 11th of the month. There may have been other circumstances, of which we have no knowledge, that caused this; but we see, that, on the 12th, there is a rise in temperature with the same wind. Study this report carefully, and it will be seen that there are changes in the temperature, apparently caused by something independent of the immediate and direct heat of the sun; for, when these observations were made, the sun had been absent for several hours. This will be made clearer later in this chapter. Observe also, that, when it is calm, there is a decided rise in the temperature. This we will also consider another time.

XV. **AIR EXPANDED BY HEAT.** — Take a thermometer into a room lighted by gas or other lamps,

and place it on the floor, leaning against the wall or furniture. Let it rest a few moments, and then make a note of the temperature. Now hang the glass on the cornice at the very top of the room (not over a lamp or near an open window), and, after a few moments' rest, examine it again. It will be found much higher now. Plainly, it is warmer at the top of the room than at the bottom. We must find a reason for this.

The lamps (and fire, if there is one) give out heat. We might imagine that the heat, for some reason, went to the top of the room, leaving the lower part cool. There is plainly more heat next the ceiling than next the floor. We must look to the air for an explanation of this matter. The effect of heat upon air is to cause it to expand. Hot air requires more room than cold air. This is shown in the old experiment of filling a bladder with air, and placing it before a fire. If air expands when heated, and requires more space, it plainly must find more room somewhere; and the easiest way to get more room is to move upward. It cannot go downward; because it meets the floor of the room, or, out of doors, the solid ground. It therefore rises, because it meets with the least resistance in that direction. The air heated by the lamps expands, and rises to the top of the room. If the room were air-tight, it would press against the walls in every direction, and try to get out. If heated enough, it would finally tear the walls apart in its effort to find more space: this we should call an explosion. However, this rarely happens; because the walls are never air-tight, and

the pressure is relieved by the escape of a part of the expanded air through the cracks in the windows, or up the chimney. Out of doors this takes place on a much larger scale. We make a bonfire in the open air, and we see the smoke rising rapidly. The smoke is really heavy, but is carried upward by the expanding air swelling and increasing in the heat of the fire, and rushing upward to find room to expand, taking the smoke with it. The smoke of itself would not rise; and, as soon as it escapes from the heated and expanded air, it will fall. This you can prove by placing a bit of paper in a strong glass bottle, setting fire to the paper, and quickly corking the bottle. In a few moments the smoke that fills the bottle will be cold; and then, if you turn the bottle over, you will see the smoke fall slowly down, thus plainly showing that it has weight, and is heavier than the air in the bottle.

XVI. **THE WINDS CAUSED BY THE SUN.**— Now, the sun is a great fire heating the air that surrounds the earth. The air warmed by the sun expands, and, wanting more room, rises towards the upper part of the atmosphere. Observe another curious thing. If air expands and rises when heated, it moves away; and any person who did not think might fancy that it would leave a hole, or empty space, behind it. This does not happen; because the air on every side is free to move, and it quickly rushes in to fill up the space occupied by the air that has ascended. This is shown by the two currents of air found at a window that is open an inch or two at top and bottom, in a warm

room, on a calm, cold day. The warm air is flowing out at the top of the window to find more room to expand; and the cold air is flowing in below to fill up the space occupied by the heated and expanded air that has risen to the top of the room, and out the top of the window. This is often plainly shown by opening a window at top and bottom when the air in the room is full of smoke. The sun shining on the earth warms the air, and it rises; and at once colder air flows in to take the place of the warm air that has moved upward. We thus see the heat of the sun causes the air to move not only upward, but to flow horizontally along the surface of the land or water to fill up the space left by the heated air. This movement of the air we call the wind, and we see that the sun is the immediate cause of those movements of the air that we call the winds. Every wind that blows, be it a gentle breeze, a fresh gale, a high wind, cyclone, or hurricane, is caused by the sun. High or low, warm wind or cold wind, east wind, south wind, — all are moved by the sun. In making our observations of the wind, we find it blows in many directions, and that these directions often change. This is an important matter; but, for our studies of plant and animal life, it is sufficient to group them all into two classes, — the warm winds and the cold winds.

XVII. **THE TWO GREAT WINDS.** — The great star on which we live presents one portion to the sun much more than other portions. The central part, in a belt along the equator, receives more heat than those

two portions about the two poles. The result is, that the air at the equator, or in the tropics, is heated more than at the poles. It is warmed by the sun, expands, rises, and, wanting more space, moves away towards either pole. At the same time the colder air about the poles, feeling the general pressure relieved by the escape of the warm torrid air, flows towards the equator to take its place. So in this country, in North America, we find two great winds, — a warm wind moving from the equator, north, towards the polar lands and seas, and a cold polar wind travelling due south towards the tropics. Usually the warmer tropic wind is highest, and flows over the colder polar wind; the cold wind next the ground, and the warm wind perhaps miles above it among the clouds.

It is true, there are as many winds as there are points to the compass: it is true, there are times when all winds are cold, and other times when they all seem warm. This great variety of winds felt at any one place is due to several causes. The two great winds may meet, and unite to give rise to a wind of another direction. Bodies of water, like our sounds and lakes, may affect the direction and temperature of winds. Ranges of mountains may turn the winds aside, and give them a new direction. Circular storms and small local storms may also create local currents of air. We must look at this matter in a general way, and study the winds as affecting the whole country. We wish to consider the wind solely as affecting temperature; and with a little study we shall see, that, in

this view of the winds, there are only two, — the warm wind from the south, and the cold wind from the north. We can divide the winds into two groups, the warm winds and the cold winds; and one group is plainly southerly, and the other as plainly northerly. The warm winds extend from south-east to west. The cold winds extend from north-west to east. All between south-east and west, inclusive, are warmer than all or any of those between north-west and east. Turn again to the two reports of temperature in paragraph XIV., and study the temperatures while these different winds blow, and it will be seen, that, in a general way, these facts hold true, and that we have two groups of winds, — the warm southerly, and the cold northerly.

XVIII. **SHELTER FROM WINDS.** — We have already learned that the air is warmer near a building than in an open field. We found the sun warmed the air more rapidly when the air was confined, as in a sunny room, or in a cold-frame or greenhouse. We found it warmer on a sunny day, on the south side of a building or fence, than in an open field. We can now understand why the south side of such a fence or building may also be warmer even in the night, or on a cloudy day, when there is no heat from the sun. If the southerly winds, warmed in the tropics, are warmer than those from the regions round the north pole, clearly the south side of a fence or building will, in the long-run, be warmer than the north side of the same fence or building; perhaps not at any one time in the night, or upon a cloudy day. We

may make observations on both sides at the same time, as on a warm, moist day or night in the spring, or on a very cold night in January, and find the glass just the same on each side. We must consider this matter as spread over a month or a year. If we made observations of the temperature on each side of the building, or on the south side of the building and in an open field, every night for a year, we should find that there would be more days or nights when the glass was higher on the south side, than days or nights when it was the same on both sides, or on the north side and the open field. Again study the reports in paragraph XIV. Observe that on the calm nights it is always warmer. This state of rest, or calm, is practically the same as a shelter. A fence shelters the ground, and makes a little calm near the fence; and the heat accumulates, and the temperature rises. It is the same in a calm.

XIX. **RADIATION OF HEAT FROM THE GROUND.** — This is a curious matter, and we must look about to see if we can find a reason for it. Go out in the night, when there is a fresh wind from the north or north-west. The wind feels cool upon the hands and face; and, if it is winter, it may be uncomfortably cold. Stand in the full wind for a moment. The air is cold, and as it moves past feels colder and colder. Now go behind a tight board fence, or some building out of the wind. It feels more comfortable here, and seems warmer in the calmer air sheltered from the wind. Now, there may be two reasons for

this. One reason is, that, as the air next your face and hands is still, it absorbs the heat of your body slowly, and you feel warmer than when in the open field, when the wind sweeping over you took up your bodily heat, and, carrying it continually away, quickly lowered your temperature. Another reason is, that the sun shining on the ground the previous day warmed it, and when the sun went down the earth slowly gave up its heat to the air. In the open field the ground may also be giving up its stored heat to the air; but, as the air is in motion, the heat is swept away and lost. Here in the shelter from the wind, the heat given up by the ground has a chance to accumulate in the calmer air. This curious behavior of the ground, in giving up its heat to the air in the night, is plainly shown by covering the ground with paper or cloth. The gardener, wishing to save his plants from early frosts in the fall, covers them with cloth or paper. In the morning he finds the plants under the paper or cloth unharmed, while other plants in the same garden may be killed by the frost. We cannot think of the cold as falling down like so much rain or snow, and being thrown off by the newspaper spread over the plants: it is nothing like this at all. The sun shone on the ground the day before, and warmed it. At night the heat freely escaped into the air, and the ground grew colder and colder till the sun returned in the morning. The newspaper spread over the plants kept the air quiet under it. The heat of the ground escaped into the air; but, as the air could not

get out from under the paper blanket, it remained warm. The paper simply prevented the heat from escaping; and the air about the plants, and the ground too, remained warm, and the plants were saved from freezing. In like manner the ground in the shelter from the wind may warm the air, and the air itself being quiet may go on storing up the heat from the ground. The heat is saved in the sheltered place, and lost in the exposed open place. For the same reason, a calm night is always warmer than a windy night, as is plainly shown by our two reports. In the second report, you observe that it is usually warmer on cloudy nights than on clear nights. The clouds act as a blanket, and prevent the radiation of the heat from the ground. There is radiation of heat even from frozen ground in winter, and clouds serve to check this loss of heat.

XX. **VALUE OF SHELTER.** — In the paragraph (XIII.) on "forwarding" plants, we saw the advantage of placing our early plants in the right aspect, or in places where they would receive the greatest amount of sunlight. Read this paragraph again. We now add another fact to those we learned then. We find that shelter from the wind also helps the farmer, the poultry-man, and gardener. We find now that shelter from the cold winds — the north-west, north, north-east, and east winds — benefits plants and animals by saving the heat of the sun by night as well as by day. In this way our experiments again become of practical value, in pointing out the best place for a garden, or

the best position for a hot-bed, or plant-house of any kind. They show that the farmer who makes an open shed for his cattle, where they can take the air in sunny days in winter, with the open side of the shed to the north-west, would be careless alike of the comfort of his animals and his own property, and as ignorant as he is cruel. As in considering the aspect of a garden, in the other paragraph, we again find the value of location in regard to the points of the compass. A flower-bed on the south side of a house is better than one on the north side, and a sloping field on the south-east side of a hill will be better for early crops than one on the north-west side of a hill. Just as we found when standing in the open field at night, exposed to the north-west wind, that the wind swept through our clothing, taking our bodily heat rapidly away, — precisely in the same way a barn or house or greenhouse fully exposed to cold winds will be colder than one sheltered by trees or a hill. The wind blows through the cracks of the barn or house or greenhouse; and the plants, animals, or human beings will need more clothing or more fires to keep them warm. For this reason, city houses are warmer than isolated country houses; because one house shelters another from the wind. Cows kept in a tight barn sheltered by trees or other buildings will be warmer, and will give more and better milk, than equally good cows in a poorly built barn exposed to cold winds, or allowed to stand in the daytime in winter in cold, windy yards. In this study of shelter we have con-

sidered only the heat of the wind. We now see the value of shelter from the cold winds to save heat. The warm winds we are glad to welcome; and we need no shelter from them, except in those few instances where we wish to keep things cool. An ice-house would plainly be better on the north side of a grove of trees or a hill, away from the warm winds. If we wished a late crop of strawberries, we might select the north side of a hill for our garden; because it would be cooler, and the plants would be delayed in ripening their fruit.

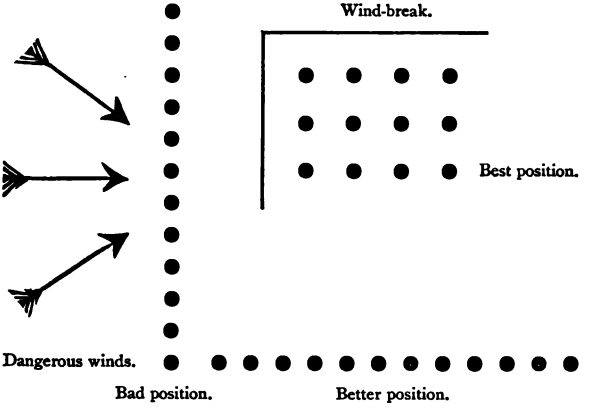
XXI. **MECHANICAL EFFECTS OF THE WIND.** — There is one more matter to be considered in regard to this shelter from the wind. Plants and trees standing in the air are moved by it, and in some instances may be injured by the wind. This we call a mechanical effect, as when the wind shakes an apple-tree, and the apples are shaken off before they are ripe. This has plainly nothing to do with the direction or temperature of the wind. At the same time, we must consider it, if we are to raise the best fruits and flowers. When the air is moving rapidly, as in a high wind, it presses against every thing it meets. If the object is firm and strong, like a house, the pressure of the wind may be resisted, and the air forced to turn aside and pass on each side or over the top of the house. It is quite different with a tree. The stem is held firmly in the ground, by the roots; but the branches and smaller twigs that form the top, and that carry the leaves, flowers, and fruit, are free to sway and move about in

the wind. If the wind is high, the limbs and branches may be thrashed and beaten about, and the foliage, flowers, or fruit destroyed and lost. If the tree is protected and sheltered by other trees, or by a building or a hill, it may be in still air, and, being quiet, may keep its fruit or flowers, and thus save the crop.

We cannot easily try any experiments to prove which of the various winds that blow is the strongest. It would require a great number of observations to find this out. We can only take the records of observations taken over many years. The Signal-Service reports will give us this; and, from these reports, it appears that the prevailing winds in North America are westerly. By "the prevailing winds" is meant, that certain winds prevail or blow for a greater number of days in a year than other winds. The prevailing winds are south-west, west, and north-west, or in a general westerly direction. There are more days when the wind is westerly than when easterly or in other directions than south-west, west, or north-west. Therefore, to protect our trees and plants from injury by high winds, they should be sheltered from these westerly winds. If we are planting an orchard, a hillside sloping to the east or south-east would be better than one sloping to the west or north-west. Our land may be level, and we wish to plant an orchard. The best plan will be to plant the trees in a solid mass, because then those on the west side will protect all those to the east. If we planted the trees in one long row north and south, plainly they would all be exposed to

the wind. If we planted the trees in one long row east and west, the trees at the west end of the row would in part protect the others. The square orchard would clearly be the best; but a better plan still would be to plant in a square, and to set up a row of forest-trees to serve as a screen, or wind-break, along two sides of the square, the west side and the north side.

The following diagrams, showing the positions of twelve trees, explain this matter clearly: —



In cultivating flowers, shelter from high winds is very important. A flower-garden on an exposed hillside open to the west, north-west, and south-west winds, will not give so many or so good flowers as one well sheltered from these winds. A certain amount

of motion in the air does no harm to trees, plants, or flowers. Driving rain, squalls, thunder-storms, and drifting clouds of dust from a road, will often destroy the work of weeks in the flower-garden. The more delicate garden-flowers, like the fuchsia or begonia, are quickly destroyed by rough winds; and, to get perfect flowers of any kind out of doors, protection from the prevailing winds will be found of the utmost importance. The great beauty of greenhouse flowers springs, in part, from the still and sheltered air in which they bloom. And, for some of the more delicate flowers, it is found nearly impossible to produce perfect blooms out of doors, on account of the injury by rough winds, beating rains, and thunder-storms.

CHAPTER IV.

CLIMATE.

XXII. **LAND AND WATER.** — When we come to observe the surface of the planet on which we live, we find that it is divided into two unequal portions. The larger part is covered with water; and the smaller part stands up above the level of the seas and oceans, and makes the dry land. It is upon the land, only, that we find the plants that make so large a part of the wealth we gather from the ground. A few varieties of plants grow under water, and do not appear to belong to the land; yet all of these are found in shallow water near the shore, so that, practically, all plants belong on the land. If we observe any plant growing on the dry land, from day to day, we shall find, that, whatever its habit of growing, it cannot grow or even live without water. Take any plant growing in a pot, and place it in a dry place where no water will come to it, and it soon begins to show signs of distress. It droops and withers, and, in a short time, dies. We recognize that it is alive, and must be supplied with water precisely as all animals must have water to drink. How and why it drinks, we cannot now stop to consider. What we wish to observe now

is, that plants require water. We learn that the larger part of the earth is covered with water, and we have now to consider how the water in the seas is brought to the plants on the dry land.

The story is, that a fool, having set out upon his travels, came to a rapid river, over which he could not pass. Observing that the water was flowing swiftly down the stream, he concluded to sit down by the bank, and wait till it had run past. Now, from the man's point of view, he was not so foolish as he appeared. If he had extended his observations to the mountains and highlands where the stream started, he might be quite correct in thinking the time would come when the mountains would be drained, and the stream run dry. This happens every summer in some places; and the streams do actually run dry, so that we can walk across the river-bed dry-shod. If he had extended his observations still farther, he would have found, that, so long as the sun and the seas remain, the streams will not run dry. In this matter, half the facts are as bad as no facts at all. The fool knew half the truth, and came to a foolish conclusion. Had he known the whole truth, he would have been a wiser man. We must beware, lest we, like the fool, jump to half a truth. We see the streams everywhere running through the valleys, and plainly watering all the plants, the trees, and the grasses that grow upon their banks. We might think the water thus supplied to the plants along the edges of the streams came from the hills where the streams rise. It does indirectly; and yet, in

reality, it all comes from the seas. We see, also, that many plants do not grow near any streams; and, in many instances, the streams are actually taking the water away from the plants. This we see on every wooded hill and mountain, where the brooks and rivulets are flowing swiftly away from the forests.

XXIII. **THE RAIN.** — Fill a clean, dry tumbler with small pieces of ice, and place it in a warm room. In a few moments the outside of the glass will grow misty and wet; and presently drops will gather, and run down upon the table. Scatter a tablespoonful of fine salt over the broken ice in the glass, and more water will appear on the glass, and presently will turn to white frost and ice. This frost we can scrape off, and see it melt and turn back into water. In this experiment we obtain water and frost, or frozen water. The water clearly did not come through the glass from the inside; and the question is, Where did it come from? It must come from the air. We see the kettle boiling on the fire, and see the steam rising and floating away till it disappears in the air. We know, that, even if the kettle holds a quart of water, the heat of the fire will in a certain time entirely evaporate the water, and it will completely disappear. We cannot think the water is destroyed, and we are sure it is somewhere unseen in the air. Our ice-goblet merely brings it back, and makes it visible. So we find that heat will cause the air to take up water, and hold it as invisible vapor, and that less heat or cold will cause it to return to its visible and liquid form. We go out of

doors in the evening, at the end of a warm, clear day. No rain has fallen, and yet we find the grass and other plants wet with dew. The grass is colder than the air; and, as with our ice-glass, the invisible vapor in the air condenses, and appears as water, or dew, upon the grass.

XXIV. **THE SUN THE RAIN-MOVER.**—People in the country will sometimes point to a beam of sunlight shining through the clouds on a warm summer day, lighting up the fine dust and vapor in the air, and will tell you that "the sun is drawing water," and that we shall have rain soon. A little observation will often show you that they are mistaken; for the spot where the beam of light falls may be a dusty road, or the top of a house, where there is no water to be drawn up. At the same time, there is a grain of truth in this mistaken notion. The sun is the great water-mover that supplies all the plants on the land, with fresh water from the sea. The sun shining upon the surface of water in a pond or lake, or the water of the sea, causes a portion of it to evaporate, and rise as invisible vapor in the air. It acts as the fire under the tea-kettle upon the stove, in causing the water to evaporate and disappear in the air, except that it is much slower, and on a much larger scale. The sun shining upon the Gulf of Mexico and the tropical seas, causes the water to evaporate, and rise in the air. The air, also heated, expands, rises, and moves away to the north as the great, warm, southerly winds, taking the water with it. In time the warm, vapor-

laden winds meet the colder winds; and the invisible vapor becomes visible as mist, fog, and clouds. If the temperature falls still more, as the warm winds move farther north, the clouds condense, and the mist falls in drops as rain. In like manner, the warm, vapor-laden air may meet cold mountains or still colder air, and have its vapor condensed to clouds, rain, hail, and snow. We now see the folly of the man who waited for the river to flow by. There is no end to the circle. The sun evaporates the water from tropic seas. The winds carry the vapor over the land; and condensed by colder winds, by meeting mountains, or the cold surface of the ground, it appears as dew, or falls as rain that drains into the brooks, streams, and river, and flows back to the ocean from whence it came. So long as our atmosphere, the sun and the earth, the lands and the seas, remain, this will continue, and the streams will not run dry.

We must here observe one thing more. The people who, on seeing a dusky beam of light through a rift in the clouds upon a summer day, tell us the sun is drawing water, do, in another way, hit upon a half-truth. The sun shining upon the ground and fields does cause a certain amount of evaporation; and this invisible vapor rises, and condenses into clouds in the immediate neighborhood. These local clouds may condense, and fall as local showers, and so add to the general rainfall. This operation takes place frequently on warm summer days; and serves to economize the supply of rain, by returning some of the water raised

from the ground back to the earth. How far this happens, we have no means of knowing; yet we may feel quite sure that the main supply upon which we depend comes from the great seas that surround all the continents. The local showers help us. The great storms bring us water from the seas.

XXV. **THE RAINFALL.** — These observations, in a general way, explain the source and movements of the water to all the plants growing on the surface of the ground. For our studies of plants, it is only necessary to observe that there is a difference in the rainfall at different times and places. By the rainfall is meant the amount of rain that falls in any one place in a year. The rainfall varies all over the country, being much greater in some places than others. The amount of rain that falls is affected by mountain-ranges, by the distance from the sea, by plains, and by the shape and direction of the coast. These are very interesting matters, and would repay careful study; but, for our work upon the land with plants, we only need to know the rainfall of the particular place where we live and are at work.

XXVI. **THE RAIN-GAUGE.** — We can, by consulting the reports and maps of the Signal Service of the United-States Government, find out just what the rainfall may be in any part of the country. We can find recorded in books just about how much water falls as rain or snow or hail in every State in the Union. It would seem a good plan to do this, and thus save all trouble. It is a good plan. It is a far better plan

to find out for ourselves. We may read that the rainfall in our State is three inches and a half, or four inches, or something else; yet we may have very little real knowledge of the fact. Measure the rainfall of the place where you live, and you will be sure to learn in one month more than you could ever learn from a book. To read that a quarter of an inch of rain fell in an easterly storm, is one thing: to find it out for yourself, is quite another.

To measure the amount of rain that falls, an instrument called a rain-gauge must be set up in an open place, out of doors, away from trees or buildings. It consists of a metal vessel about ten inches deep and two inches wide, and having a flaring top to collect the water. Such gauges can be bought for about two dollars. When clouds appear, and it seems likely to rain, the rain-gauge is placed on top of a post, and securely fastened so that it will not be blown down by the wind; or it is sunk in a hole in the ground, but sufficiently high to prevent any of the rain falling near it from spattering into the gauge. The best plan is to put it on a post raised a few feet above ground. A cheaper instrument can be made by any tinman, by making a zinc tube two inches in diameter and six inches long, and closed at one end. Set this on the post; or, if in town, on top of the roof, away from the chimneys, and high enough to escape the spatter from the roof. After the rain has ceased, bring the gauge into the house, and carefully measure the depth of the water inside, in inches and tenths of inches. This will

give the rainfall. If there is half an inch of water in the gauge, then we say the rainfall is half an inch. This means that enough rain has fallen to cover the entire surface of the ground one-half inch deep. If the larger rain-gauges having the flaring tops are used, much more water will be found in the vessel than in the plain, straight gauges. To get at the true measurement, the depth of the water must be divided. The usual plan is to divide by two; and, if the vessel contains two inches of water, it means that only one inch has fallen. If you can find no better instrument, a glass tumbler, with flat bottom inside and perfectly straight sides, will make a very fair rain-gauge. It is better to take this than to do nothing. Drive four nails into the top of a post, and place the tumbler between them when it threatens to rain.

Carefully put down full records of all observations with the rain-gauge. Make a note of the date; and, if in the daytime, the hour the rain began, and the day and hour it stopped. As soon as the rain stops, or early the next morning after a stormy night, carefully measure the depth of the water in the gauge, and add this to your record. If the gauge is full of snow, place the gauge near a fire, and melt it, and measure the water as soon as the snow is melted. Do this for not less than one whole month, or, better still, for a whole year. A single experiment will teach something. A year's observation will give you many valuable facts.

Here are reports of rainfall, from actual observations taken at Houghton Farm : —

RAINFALL AT HOUGHTON FARM, IN JULY, 1884.

Date.	Began.	Ended.	Rain in Inches and Hundredths.
4	Rain, 3 P.M.	Night.	0.75
5	Shower, 8 P.M.	Night.	1.46
8	Showers, 1.30 P.M.	On the 9th.	0.27
11	Showers, 2 P.M.	4 P.M.	0.91
12	Showers, 3 P.M.	Night.	1.07
13	Showers, 1.30 P.M.	1.50 P.M	0.63
19	Showers, 3.35 P.M.	4 P.M.	0.15
23	Showers, 6.30 P.M.	Night.	0.57
25	Rain, early morning.		0.22
27	Rain, 12 M.	Night.	1.21
29	Rain, early morning.	7 A.M.	0.18
29	Rain, 11.40 A.M.	Night.	0.28
31	Rain, 11 A.M.	5 P.M.	0.02
	Total	. . . . .	7.72

RAINFALL AT HOUGHTON FARM, FOR AUGUST, 1884.

Date.	Began.	Ended.	Rain in Inches and Hundredths.
4	Showers, 12.30 P.M.	Night.	0.74
5	Rain, 2.45 P.M.	Night.	0.21
7	Rain, 12.30 P.M.	5 P.M.	0.01
8	Showers, 3.50 P.M.	4.50 P.M.	0.06
10	Showers, night.	Night.	0.35
11	Showers, 8 P.M.	Night.	0.35
21	Thunder-shower, early morning.	Early morning.	0.15
22	Thunder-shower, 12 M.	Evening.	0.69
25	Rain, 9 P.M.	9 A.M., 26th.	0.32
29	Rain, early morning.	4.30 P.M.	0.72
30	Thunder-shower, 5.15 P.M.	Evening.	0.16
			3.41

Further reports can be made by adding up the rainfall in the different showers, rain-storms, or thunder-storms, and dividing by the number of each to get the averages of each of the three kinds of storm.

It will be observed, that there is a great difference in the amount of rain that falls in the different storms; a single thunder-shower giving more water than a storm extending over two days. Compared with the same months in other years, these reports show that the rain-

fall for July was very heavy, and for August was somewhat, though not much, below the average.

XXVII. **CLIMATE.** — All of these things that we have been considering — the sun, the temperature, the winds, clouds, and rain — go to make up what is called the climate. Their aspect and operations from day to day make what we call the weather. The climate in which we live, and the character of the weather we have in a year, decide what plants we can cultivate in the particular place where we reside. It is for this reason that we have been making these many observations. If wealth comes from the ground, in the form of plants that we may eat, or use in other ways, plainly we shall never grow rich unless we understand our climate, and cultivate those plants adapted to it. Every plant grows and thrives in a particular temperature. If it is too cold or too warm, it will fall ill and die. If the summer is too short, it will be cut down by frosts before its fruit is ripe. Oranges do not grow in Maine, neither can you find thick grassy lawns in Florida. Some apples are fine, large, and juicy in New York, and poor enough in Texas. The cactus opens its wonderful flowers in the dry air of Mexico; and the lily of the valley blooms in the cool, damp shade of Massachusetts gardens. The rice-plant, the wild aster, the cotton-plant, and sage-bush have each their home; depending not alone on the soil, but on the climate, the sunlight, the temperature, the winds, and the rainfall.

The climates of the world are divided, for conven-

ience, into three great classes, — the warm climates, that extend around the world on each side of the equator, in the torrid zone; the temperate climates, on each side of this zone; and the cold climates, about the poles. There are also dry climates and wet climates, depending on the amount of the rainfall. While we might spend much time in studying this interesting matter of the climates, we must remember that our aim is to find the sources of wealth in plants in the particular place where we live. It is only important for us to understand perfectly the actual climate of the particular place where we live. This we can find out by a series of regular observations of the behavior of our climate, as shown by the weather, from day to day. We can also find it all in books, but we shall never understand it so well as when we find it out for ourselves.

XXVIII. **WEATHER OBSERVATIONS.** — The most important point to be studied in regard to the climate in any particular place is the temperature. We must know how soon in the spring it is safe to plant seeds or set out plants, how early in the fall our greenhouse plants must be taken into the house, how long we can leave our crops in the fields before biting frosts destroy them. One observation each day will be sufficient; and, for this hour, we will choose seven o'clock in the morning. We have observed, that, by the daily motion of the earth, the sun shines on one particular spot all day, and supplies more or less warmth to the air. At night the earth and the air

rapidly part with their heat; and, if the night is calm and clear, it will grow steadily colder all night. On such nights it is coldest in the early morning, before the sun begins again to raise the temperature. For this reason we select seven o'clock, as being usually the coldest hour of the twenty-four. Another reason for this hour is the fact that the United-States Signal Service, and a great number of private observers, have selected this hour; and thus all reports are uniform, and tell the exact truth at a fixed time. Place the glass in some convenient position outside of a window, in any aspect except east, and away from any chimney, veranda, or overhanging cornice. The following directions, prepared for the members of the Chautauqua Town and Country Club, show how to make a report of the temperature for any one month in the year.

1. Rule on a sheet of letter-paper thirty-one vertical lines a quarter of an inch apart, and number at top from 1 to 31. Rule over these, half as far apart, sixty horizontal lines, and number upward from 30 to 90. Place a dot at junction of horizontal line, corresponding to height of thermometer, and line for day of month, each day at seven A.M. The observation should be made daily at exactly seven o'clock. At end of month, join all the dots together by straight lines. See the sample chart opposite page 57, it being one month's record at Houghton Farm.

The Signal-Service observers also make reports of the temperature at other hours of the day. As the

welfare of any plant growing out of doors depends on the lowest temperature it may have at any time, this early morning observation will tell all that it is essential for us to know. Plants are also injured by too high temperatures; but, if the record of the coldest hour of the twenty-four is very high, we can always feel sure it is higher still at other hours of the day or night. Lettuce becomes hard and tough, and quickly runs to seed, in the hot weather of July. The morning temperature of that month is high. It is lower in May; and we see May is a better month for lettuce than July, even if we do not know what the noonday temperature of either month may be. The seven-o'clock temperature in Florida during May is higher than in February. This is also true of Massachusetts, but with a difference. In Massachusetts the temperature is below freezing, nearly every morning through February. Plainly the lettuce will not grow there. In Florida the temperature may be just right for lettuce in February, and all wrong or too high in May, at the very time it is just right in Massachusetts. We see at once that any man having made these seven-o'clock observations in either State, could decide in each State when to plant his lettuce. If we had two reports from these two States, in February and May, and did not know in which State they were taken, and were then told that lettuce grew well in one place and not in another, we could decide exactly in what State the plants grew. These things show how valuable these observations of the temperature may be. It may be thought

that no man would be so foolish as to plant lettuce with the snow on the ground. Perhaps not; yet every spring hundreds of people plant seeds, and set out plants, too early or too late, simply because they do not know the daily temperature of the climate in which they have lived all their stupid lives. Tens of thousands of dollars have been lost again and again by gardeners and florists, because they left their plants out too late in the fall; when three minutes' work once a day for a month might have saved them from all the losses that now spring from their ignorance and carelessness.

Another subject for observation is the direction of the wind. This should be done at seven o'clock A.M., and may also be reported with observations on the state of the sky, whether it is "clear," "fair," or "cloudy." These two reports are included in the example opposite page 57. Directions for both observations, designed for the members of the C. T. C. C., are here given: —

2. Report, at same hour each day, direction of wind, by placing initials for wind at foot of vertical line for No. 1. Work No. 2 also goes well with No. 3, below. If preferred, write out wind record thus: 1st, N.; 2d, W.; 3d, N.; 4th, S.W.; 5th, E.; etc. These initials are for the points of the compass from which the wind comes, in every case. If there is no wind, write "o" in the record. For example, see the chart for a month, opposite page 57.

3. Rule thirty-one short vertical lines a quarter of an

inch apart, on a sheet of letter-paper, and rule, over these, three horizontal lines; mark upright lines with days of month, 1 to 31, and horizontal lines, "Clear," "Fair," "Cloudy." Place a dot on junction of the line of each day and that for the state of the weather; join all dots by straight lines. When one-third or less of the whole sky is clouded, the record should be "Clear." If from one-third to three-fourths of the sky is clouded, the record should be "Fair." When three-fourths is clouded, record "Cloudy." The observer should stand where the whole sky can be seen. Although any hour of the day may be taken for this observation, provided it be the same hour every day, seven A.M. is the time advised.

Reports of the rainfall are valuable, and the making of the observations is excellent practice in observatory-work. The reports can be made in the graphic method (as it is called), by using vertical lines for the days of the month, and about twenty-one horizontal lines giving tenths of inches or two full inches, which will be as much as will be generally observed in any one storm. Some rainfalls are much more heavy. At one time seven inches of rain in half a day were reported at Houghton Farm. Ignorance of the amount of rain that may fall in a year has led to serious losses in farming. The farmer, buying a new farm in a country with which he is not familiar, may plant celery for a neighboring city, only to find that the August droughts just there are too severe for that crop, and thus lose his time and labor. He may give up that crop, and try something else.

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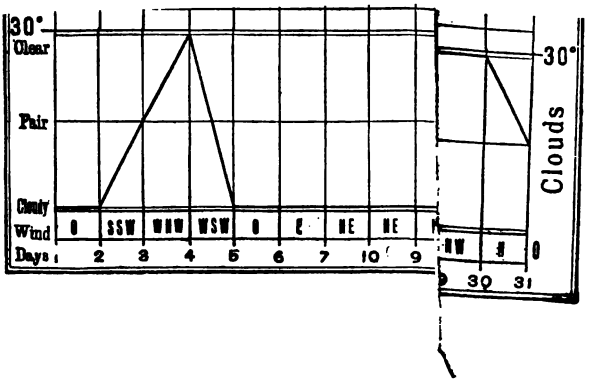


Perhaps he will; but if he is an ignorant man, and not an observer, he may say that perhaps next year the season will not be so dry; and again he will suffer loss. The rainfall is now thoroughly known in nearly every county in all the States; and there is no excuse for the farmer who plants crops that will be injured by the excess of rain, or the lack of rain, in any one place. The wise farmer will not be content with this alone. He will also make his own observations of the temperature, the rain, the winds, and the clouds.

For those who have no time or inclination to make these observations of the rain, the winds, the clouds, or temperature, and who wish to make observations of some kind, there are the casual phenomena of the weather and nature that may be made at any hour. This forms Lesson No. 4 of the C. T. C. C. programme, and the following instructions show how to do the work: —

4. Observe at any hour, and record every day, some fact in regard to the weather or any other natural phenomena, as explained in the Programme of Work. On the opposite page is a good example of such a record on the farm, for one month. Anywhere, in town or country, something can be found for record every day. Have a sheet with at least thirty-one lines on it, and give at least one line to every day. The following are some of the casual natural events which are worthy of record: High winds, storms, thunder-showers; for all these, the time of occurrence, duration, and direction of motion.

Distant thunder without visible lightning, and distant or "heat" lightning. Objects struck by lightning. Hail-storms; time of occurrence, duration, size of stones, direction of moving. Aurora borealis, or northern lights. Shooting stars. Latest frost in spring, and earliest in autumn; white frosts. Time of freezing of rivers, lakes, and large ponds. Appearance and depth of snow. Unusually heavy rains. Hazy or smoky appearance of the atmosphere. Smoke of forest-fires. Time of budding, leafing, blossoming, ripening, and fading of plants, — especially agricultural plants, trees, fruit, etc. Time of appearance, nesting, disappearance or migration, of birds, insects, etc. Occurrences of interest among domestic animals.

WEATHER RECORD (CASUAL PHENOMENA) AND FARM NOTES.

HOUGHTON FARM, MAY, 1884.

1. Three more fine lambs; these make sixty-seven, from fifty-eight ewes. American Wonder Peas, sown April 15, broke ground to-day.

2. The sun obscured by smoke about 4 P.M. Much like the smoky or yellow days in history. Max. temp., 1 to 2 P.M., 84° F.

3. The cherry (prunus cerasus) and currant (ribes rubrum) in bloom. Smoky again. A whippoorwill heard in the evening.

4. Shepherd's purse (capsella bursa-pastoris) in bloom. Golden willow (salix alba, var. vitellina) in bloom. An early sugar maple (acer saccharinum) has passed its bloom.

5. A thunder-shower, 5.45 to 6.45 A.M.; a few hail-stones. Yellowhammer (colaptes auratus), king-bird (tyrannus carolinensis), and yellow-bird (chrysomitris tristis) seen.

6. N. E. rainstorm. Temp. 59° F. to 51° F., 7 A.M. to 9 P.M. The collie pups are now fully weaned; two already sold.

7. Bobolinks (dolichonyx oryziverous) have returned. Thunder-shower in the evening. It came from S. by W. The black birch (betula nigra) is in bloom.

8. Strawberries (fragaria virginiana), violets (viola pubescens), buttercups (ranunculus bulbosus), found in bloom.

9. Shower at 7.30 P.M., from N. by W. to N.E., accompanied by thunder and hail. Set out selected Yellow Danvers onions, from last year's crop, for seed.

10 The imported Norman mare "Favorite" has a horse-colt. General crop onion and carrot seed sown to-day.

11. Baltimore oriole (icterus baltimore) seen. Set a Brahma hen on 13 Pekin-duck eggs in cabin on Crusoe Island.

12. Apple-trees (pyrus malus) and sorrel (rumex acetosella) in bloom.

13. The Department of Agriculture oats, three new kinds, are well up. Set out, in open garden, roses, carnations, and chrysanthemums.

14. Polar band at 8 A.M., E.N.E. to W.S.W. A woods' fire on Schunemunk Mountain; started from railroad.

15. Polar band at 4 A.M., E.N.E. to W.S.W. Showery during P.M. Partial rainbow at 5 P.M. Temp. of dairy-spring, 48° F.; temp. of well (office supply) 50° F.

16. Polar band at 8 A.M., N.E. and S.W. A general second planting of peas for comparison.

17. One domesticated wild goose commenced to sit, and another feathering her nest.

18. Jersey cow, "Valley Queen" (No. 7283), has a solid colored heifer-calf; sire, "Ramapo," No. 4679.

19. Distant lightning in S.W. at 9 P.M. Sheep out on the East-Mountain lot.

20. Shower of 20 m. duration at 3 P.M. Distant lightning at 9 P.M., E. and S.E.

21. Grass enough for young stock to be first turned out on hill pasture, — the Park lot.

22. Large flock of wild geese seen flying north. Currant-worms appearing; treated bushes to white hellebore.

23. Light shower during morning. Thunder and lightning north, from 5 to 12 P.M. Fireflies first seen, along Awessima Creek.

24. Thunder-shower from W.S.W. to E.N.E. First heard 8.30 P.M. Distant lightning in S.W. at 10 P.M.

25. Dragon-flies first seen. Blue-flag (iris versicolor) is in bloom. Henderson's First-of-All Peas in blossom, — ahead of all sown April 15.

26. The twin heifer-calves of "Schunemunk Lais," 9126, have been sold to go to Georgia. Peas put in the 16th are generally up.

27. Distant lightning seen on horizon, W.S.W. to S. and S.E., at 9 P.M.; and a few peals of thunder heard. Mower on lawn for first time.

28. All hands and teams to spare from farm are on highway, "working out" road-taxes. This is a poor system: the contract plan gives far better roads.

29. Largest Essex sow has a litter of nine nice pigs. Began shearing sheep. American Wonder Peas in bloom.

30. Killing frost last night. Ice formed in favorable localities. Found bronze turkey-hen, "Red-legs," sitting on eleven eggs on a brush-pile, at last winter's clearing on Mount Kiowilla.

31. Orchard-grass in bloom. All cows now at pasture daily; fed lightly in stable at night.

Another subject for observation is the barometer, and it is useful as indicating approaching changes in the weather. It should be recorded on a diagram, by the graphic method, as in the chart of the temperature.

Besides giving us valuable facts in relation to the weather, these observations make capital subjects on which to sharpen our powers of observation. Such work teaches to be accurate, to be careful and exact in reporting facts, and serves to train the mind to truthfulness and precision. Any one trying this work of observation, for one or more months, cannot fail to find himself greatly benefited in many ways. It gives something to do, something to see and do every day; and opens to view all the wonderful and beautiful works of the Creator, ever moving on — never hastening, never stopping — before our eyes. To observe, is to become cultivated, to be educated. Not to observe any thing, is to be blind, to be a stupid person, and to miss half the pleasure of living.

CHAPTER V.

ARTIFICIAL CLIMATES.

XXIX. **THE CONTROL OF TEMPERATURE AND RAINFALL.** — At first sight it would seem impossible that any means would ever be found for altering the temperature in which any plant may grow. We may place it in a good aspect, in a sunny spot protected from cold winds, and not be able to prevent cold, frosty nights in October from destroying it. We may plant our rhubarb in the same well-sheltered, sunny place, and wish it would start early in the spring. We have done every thing we can to forward the plant; yet it will not start while the frost is in the ground, and while the thermometer falls below freezing every night. The chilly air at night keeps it back, and it will not thrust its pink fingers through the soil till the temperature rises permanently. In regard to the rainfall, we can in a small way control, not the actual rain itself, but the amount of water any one plant, or even a few thousand plants, may receive. We can go out in dry weather with a watering-pot, and give the plants water when none falls from the clouds, and thus save the plants' lives.

A certain farmer, not long ago, planted a large field

of celery. All went well till August. The plants grew rapidly, and promised a bountiful harvest. If occasional showers passed overhead, or a good storm or two came, all would be well, and the farmer would clear a handsome profit on his land and labor. The weather now became fair and clear every day. Signs of rain appeared, only to pass away without a single drop falling on that great celery-crop. It began to suffer for want of water. The grass nearly turned yellow. Everybody said they were having a severe drought. Even the brook that ran through the valley, not far away, dwindled down to a small stream with plenty of bare, dry stones in its bed. The celery-plants began to show signs of distress; they stopped growing. The farmer was in despair; unless it rained soon, he would not have half a crop. Still the hot, dry days went by, and there was no rain; in another week the crop would be ruined. Unless rain came in forty-eight hours, every thing was lost.

Just then a man came along, looked over the fence at the field of celery, and asked the farmer what he would sell it for just as it stood in the ground. The farmer, not being an observer, was glad to sell out the crop for a hundred dollars. It was perfectly valueless unless it rained by the next day, and the newspapers said there were no indications of a storm anywhere. The stranger stipulated that he should have the right to take away the celery at any time he wished. To this the farmer assented; and, taking the hundred dollars given by the stranger, he went home feeling quite sure the man was a fool.

Late that afternoon the farmer was surprised to hear the puffing of a steam-engine down by the brook. Wondering what it meant, he went out to the fields, and found a small boiler and steam-pump by the side of the water. A dozen men were busily laying iron pipes up the hill to the celery-field. A poor, old, second-hand pump, second-hand pipe too, but good enough for the purpose. He said not a word, and went home a wiser and a very sad man. By nine o'clock that night, streams of water were pouring round the thirsty celery-plants; and by midnight the men, aided by lanterns and torches, had thoroughly watered the whole crop. The crazy old steam-pump puffed merrily away every day. Every celery-plant was watered as often as it could drink, and every plant seemed bound to grow bigger than its neighbor. The stranger was an observer. He saw the brook and the field, and had the enterprise to bring them together. He knew it was hopeless to depend on the rainfall. He must create an artificial rainfall. The crop was immense; and after paying for the old pipes and engine, and the use of the boiler, and the wages of the men, he sold the crop for three thousand dollars, and left the farmer his empty field as a reminder that those who have eyes and see not are apt to fall into the ditch.

Irrigation, or supplying water to growing crops, has been known for a long time; perhaps, in China, for many hundred years. Irrigating canals and ditches are used in California and other places; and they

make it possible to practically alter the climate, as far as the rainfall is concerned. We can take water from high mountains, where the warm winds drop their water as snow and rain, and carry it to orchards, pastures, and farms in dry, sterile plains and valleys where there is no rain, or so very little that no plants of any value will ever grow. Water is even taken out of wells, and used to irrigate trees and plants in desert places, so that fruits and flowers grow abundantly where only sandy, rainless wastes were found before.

With the temperature it is quite different. We cannot think of any way in which a plant out of doors could be kept warm all night through an early November snow-storm. We can place something over a geranium on a cool night in September, but we could hardly keep the frost away from an acre of tomatoes the same night. It seems, at first, quite useless to think of controlling the temperature. How can it be done? Experiment must teach us.

XXX. **THE COLD-FRAME.** — Get a few pieces of inch board, half a dozen stout stakes two feet long, and a common window-sash. The shape or size of the sash is immaterial, provided all the glass is whole. Take these things out of doors in some sunny spot in the garden, near the end of the day. It is not necessary that the sun be shining on the ground, at the time we begin our experiment. All we need to look out for is, that the ground is not frozen hard, or covered with snow, and that it is free from weeds and grass. Hang a thermometer up near by to find the temperature of

the air. Now set up the boards on edge, keeping them upright by means of the stakes, and make an open box, on the ground, the shape and size of the sash. Then lay the sash on the top to form a cover for the box. Push the loose soil up against the sides of the box to close any cracks along the bottom. In a few moments a slight mist will gather on the inside of the glass. Observe the height of the thermometer; and then take it down, and place it inside the box under the glass, standing upright against the side. In half an hour raise the sash, and examine the thermometer. It will be found slightly higher than when out of doors. Cover it again with the sash, and leave it there all night. At seven o'clock the next morning observe the temperature within the box, and then take the glass out, and observe the temperature outside. It will be found to be warmer, even under this slight shelter; and, if it rained in the night, the soil inside the box will be dry. If the day is clear, observe the temperatures outside and inside the box, again, at noon. Within the box the temperature will be found much higher than outside; and the air in the box will feel soft, warm, and damp. It is plain, that, if there were plants growing in the soil under the box, they would be in a little climate of their own, quite different from that outside the box.

Such a contrivance as this makes it possible to control the temperature, in a limited degree, over a small space of ground. It is a rude affair at best; and for real work in making an artificial climate for a few

plants, and to carry out our experiments on a larger and more useful scale, we must use much better materials. It will cost more; and, to compensate for this, we shall have something that will do actual work in raising plants that we may either sell for money, or use ourselves, and thus save money, which is practically the same thing.

Select a sunny spot in the garden, sheltered from north and west winds, and make a box six feet long (north and south) and three feet wide. Use heavy two-inch boards, and join the corners neatly, closing all cracks tight. Let the planks sink into the soil six inches, and rise above the ground one foot in front and eighteen inches at the back. This will give the top a slight slope, or inclination, to the south; and the sides must be fitted to this slope. For a cover, we need what is called a hot-bed sash. This is a wooden sash six feet long and three feet wide, and having bars only one way. It is glazed with glass made to lap, like shingles, one piece over the other; and, when laid on the wooden frame, it admits the sunlight, and sheds the rain like a roof. Such a structure is called a *cold-frame.* The name means that it is a frame or enclosure covered with glass, and having no steam-pipes, flues, or other appliances for keeping it warm. To raise the temperature inside, we have to depend on the heat of the ground under it, and the heat imparted to the ground and air inside by the sunlight that passes through the glass. Such a cold-frame may be increased in size, by extending it sideways, and placing

more sashes side by side on top. In market-gardens near our large cities, cold-frames, often one hundred feet long, are placed in rows covering many acres of land, and containing tens of thousands of plants. Such frames serve to give work and support to a great many people, and supply large quantities of food to the people living near.

Our experiments in the absorption of heat by confined air, in paragraph XII., plainly showed us why the temperature in a cold-frame exposed to the sun is higher than the air; and we have now to consider how the little artificial climate in a cold-frame can be controlled. Place the thermometer inside the frame, at seven o'clock some clear morning in April, May, September, or October. Use these months in the Northern States, and January, February, October, or November in the Southern States. Observe and record the temperature in the frame at seven and eleven A.M., three, six, and nine P.M., and again at seven A.M. the next morning. It will be found something like this: —

7 A.M.	11 A.M.	3 P.M.	6 P.M.	9 P.M.	7 A.M.
40°	90°	110°	60°	50°	40°

If not precisely like this, it will resemble it greatly, being perhaps lower at the beginning, and perhaps higher at three P.M. If the experiment is performed in summer, the range will be higher, if in the winter lower; but, in either case, the proportions will be about the same. For nearly all our low-growing garden

plants and flowers, like the violet, pansy, lettuce, and radish, this temperature is high enough at night, but far too high during the middle of the day. Our artificial climate is too warm. To correct this, we watch the glass inside; and, when it begins to rise above 80°, we lift the sash about an inch at the back, and put a stone or bit of stick under it to keep it open. The heated air will now escape through the crack at the upper side of the frame, and the temperature will rise no higher. With a little practice we can learn to adjust this opening for the escape of the hot air, so nicely, that the temperature inside the frame will neither rise nor fall for several hours. At three o'clock the sun begins to move away; and, if left open any longer, the temperature in the frame will begin to fall rapidly. We now let the sash down, and close the frame tight. The temperature will now fall very slowly all night, till it reaches (if the night is clear, and there is no change in the wind) about the same point as at the previous morning. The range will then be like this: —

7 A.M.	11 A.M.	3 P.M.	6 P.M.	9 P.M.	7 A.M.
40°	80°	80°	70°	60°	40°

In such a range of temperature, violets, pansies, lettuce, radishes, carrots, turnips, and many other plants will grow, bloom, and ripen precisely as in the open ground. We have created a suitable temperature for them; and, by giving them water whenever they need it, we can give them a special climate, over which we have entire control.

We may suppose that such a cold-frame has been constructed, and that it is desired to cultivate plants in it. We see that the frame is dry inside, and so arranged that no rain-water on the ground outside of it can leak into it, and then place good soil inside, filling the frame to within ten inches of the glass. The surface of the soil may have the same slope as the glass, so that all the plants will be equally near the glass. A good plant to try is the French breakfast-radish; and a good time to try the experiment is the spring, as soon as the temperature out of doors does not fall below 25°. When the soil is ready, select a pleasant day to plant the seeds. Water the soil well, and close the frame. No harm will come if the frame is kept closed the first day. If the night promises to be clear and cold, or if a cold storm begins, cover the sash with a piece of old carpet, a straw mat, or a shutter made of matched boards. Take off this covering the next morning, unless it snows, and after this follow this simple plan: Keep the frame closed every day unless the sun shines; open the frame at the top as soon as the temperature inside rises above 80°, and close the sash by three o'clock in the afternoon, or as soon as it becomes cloudy at any hour. Lift the sash to water the plants, only on pleasant mornings.

By such a management of the frame, we create for the plants in it a special climate, that is warmer at night and during cloudy and stormy days, and much more even and less liable to sudden changes, than the climate outside. This artificial climate will be free

from cold, beating rains, droughts, and rough winds. In it plants will grow faster than in the open air, and, if we are skilful in the care of the frame, will produce good crops.

XXXI. **THE COLD-GRAPERY AND ORCHARD-HOUSE.** — The cold-frame is the oldest and the most simple means we have of creating a special climate in which large numbers of plants may grow. There are also hand glasses, and small boxes covered with oiled cloth or glass, used to place over single plants growing in the open ground, to protect them from cold weather; and these smaller appliances have to be used in the same way. If the sun becomes too warm, they must be raised to allow the escape of the excessive heat, precisely as with the cold-frame. This same plan of using glass to save the heat of the sun, and create an artificial climate, is carried out on a large scale in the structures known as *cold-graperies* and *orchard-houses*. These are buildings with glass roofs and sides, in which grape-vines, peach, cherry, and other fruit trees, may be cultivated, either in the ground or in large pots, and in an artificial climate. The sunlight, passing through the glass roof and sides of the buildings, warms the air inside; and, by means of ventilators in the roofs, the excess of heat may be allowed to escape. Strawberries in pots placed on shelves can also be cultivated in such a house; and, if of the right shape, such a building may be used for melons and cucumbers. Whatever its shape, size, or use, it is managed on the same principles as the cold-frame.

In the night, and on cloudy and stormy days, it will be about ten degrees warmer inside than outside. As soon as the sun shines upon the building, the temperature inside will rise rapidly. If too high, it can be prevented from rising higher by opening the ventilators. By closing the house early in the afternoon, the heat of the sun may be saved to keep the place warm by night.

XXXII. **THE HOT-BED.**—The next step made in controlling these artificial climates under glass was to warm the air in a frame or other structure, by means of a fire, or some other arrangement for giving heat. If leaves, hay, straw, sawdust, or tan-bark be left in a heap, it will give out heat. It ferments and decays; and if a stick is thrust into the heap for a moment, and then drawn out, it will feel quite warm to the hand. This heat of fermentation is used to warm the air of a frame in which plants may be growing. Leaves and tan-bark can be used for this purpose, but fresh manure from the stable is found to be much better. The frame is made much deeper inside; and the manure is placed at the bottom, and covered with the soil in which the plants are to grow. In two or three days it will be found that the temperature within the frame is much higher at night, and on cloudy days, than outside the frame. The material under the soil in the frame ferments, and gives out heat; and this raises the general temperature of the artificial climate in the frame. We can now begin to raise plants much earlier in the spring, and have plants like lettuce and

radishes growing finely while the ground is still covered with snow.

The next step was to substitute, for the fermenting manure, brick smoke-flues, and pipes filled with hot water or steam. The heat of fermentation is highest at first, and steadily falls from week to week, till, in the course of eight or ten weeks, it is spent or exhausted; and, for hot-beds and glass buildings that are to be artificially warmed, something more reliable is preferred. This leads us to the larger plant-houses, used for raising plants of every kind.

XXXIII. **PLANT-HOUSES.** — The use of glass in raising plants forms one of the most important branches of the art of horticulture. Glass houses of every shape and size are used in every civilized country; and all our flowering-plants, all our fruit-trees and garden-vegetables, and many of our field-crops, have been cultivated at some time in such buildings. Glass houses range in size from a little conservatory attached to a dwelling-house, to a crystal palace giving shelter to tall palm-trees, as the Crystal Palace at Sydenham in England. They are given a great variety of names, according to their use; as, *plant-house*, *greenhouse*, *stove*, *orchid-house*, *melon-house*, *forcing-house*, *propagating-house*, *palm-house*, *rose-house*, *orangery*, *pine-house*, and so on. They are usually built in one of two shapes, — a "lean-to," with a single roof sloping one way; or a "span-roof," having two roofs meeting at the centre, and pitching in opposite directions. All are distinguished from the cold-house, grapery, and

orchard-house, by having some means — a stove, or hot water, or steam-pipes — for warming the air under the glass. The most common glass building is the *greenhouse*. This may be either a "lean-to" facing the south, or a "span-roof" with the ridge of the roof placed north and south. In a greenhouse, nearly all our more common garden-plants and house-plants can be cultivated; the temperature in the house never rising above 80°, or falling below 50°. A *hot-house*, or *stove*, is a glass house resembling a greenhouse, but kept much warmer; the temperature never being allowed to fall below 70°, and often rising on sunny days above 90°. In the *hot-house* the artificial climate resembles the climate of the tropics; and tropical plants of all kinds will grow and bloom in the moist, warm atmosphere of such a house. As all plants require a special climate, it is found best to place many plants in special houses; hence we have *rose-houses*, *palm-houses*, *orchid-houses*, *ferneries*, *melon-houses*, and other houses adapted to particular plants. In construction the buildings may be much alike, yet in each the climate may be very different. The geranium and heliotrope will get on quite comfortably together in one house, where a delicate orchid would soon die. Pine-apples want one climate, and violets quite another. Young tomato or cabbage plants may grow nicely in one house, while the maidenhair-fern would not grow at all in their company. By having more fires or less fires, more water or less water, we can imitate the climate of any part of the world, and suit each plant

to its particular wants. We can arrange the heat and moisture so that every plant will find just what it wants, and feel perfectly at home in a purely artificial climate.

This use of glass in enabling us to create an artificial climate has made it possible to hasten or retard the seasons at will. We can have strawberries in March, and roses all the year round. It makes it possible to grow pine-apples in England, and all the strange and beautiful flowers of the Amazon Valley in every Northern State. Without glass houses the tomato would not grow in New England, and many of our common garden flowers and vegetables would never be seen except in the Southern States. Millions of dollars have been spent in England and in this country, in building glass structures of all kinds; and great numbers of people earn a comfortable living in caring for plants growing in these artificial climates. In May and June over a hundred thousand plants raised under glass are sold every day in a single street in New-York City. All our flowers, from November to May, are raised, except in the Gulf States and California, under glass. Lettuce is raised under glass in and about Boston all winter long, and shipped to New York and other great cities by the carload. New-York City, it is estimated, consumes fifty thousand heads of lettuce weekly during the winter; and every plant is raised in an artificial climate.

XXXIV. **PRACTICAL VALUE OF OBSERVATIONS.** — Our observations of the temperature, the sun's light and heat, the wind and rain, now begin to

have a practical value. By the use of glass, we are able to create an artificial climate, in which we can regulate every thing except the actual amount of sunlight. We can have a climate always dead calm, with no cold weather or dry weather. A fire makes us independent of the sun's heat, and a pump or cistern enable us to regulate our artificial rainfall. Our observations show us the value of this control over the climate in which any plant may grow, and we have now to see the use to which our observations may be put. If we know the native climate of any plant, we can copy it exactly; and the plant, finding its surroundings homelike and natural, will grow, bloom, and ripen its fruit to perfection. We can cause the plant to grow rapidly or slowly, to bloom out of the time at which it would bloom if left out of doors, and out of the time it may bloom in its native country. We can cause it to rest and sleep, and cause it to again resume its active life. In fact, the use of glass gives us complete control over the lives and habits of plants; and, as plants are one of the chief sources of wealth, the use of glass controls the production of wealth and becomes a business. To illustrate this, we may take the common tomato-crop. In the Northern States it is very difficult, and in some places impossible, to raise tomatoes wholly in the open air. Plant the seed in the ground, and the plant will indeed come up and grow and bloom; but the greater part of the crop will be destroyed by the early frosts before the fruit is ripe. By planting the seed in a hot-bed, or glass house of

some kind (or even in a box in the kitchen window), in March, we shall have in May fine large plants suitable for setting out in the open ground. These will be six weeks in advance of plants raised out of doors, and will have an abundance of ripe fruit early in the season, and before the frost can cut them down. Vast as the tomato-crop grown for the market or sold to the canners may be (and it is one of our largest garden-crops), the whole of it is made possible by the use of glass. The entire crop is raised from plants that spend the first six weeks of their lives in an artificial climate. So great is the gain given by growing plants in the first part of their lives under glass, that many of our larger crops, like the cabbage, cauliflower, and celery, are now wholly cultivated in this way. The plan is also applied to melons and cucumbers, and sometimes to potatoes. All our bedding-plants, foliage-plants, and early fall flowering-plants also spend a portion of their lives in an artificial climate under glass. Were the use of glass given up, the price of all but a few of our vegetables, like sweet corn and beans, would be greatly increased, and our flower-gardens would be reduced to the annuals and hardy shrubs and herbaceous plants. There would be no flowers in winter, and no early spring vegetables, no Easter-lilies, no orange-flowers, camellias, azalias; no flowers whatever between the last wild aster blooming among the bare trees, and the first arbutus in the spring woods. The art of creating and maintaining these artificial climates depends on these very observations we have been

making, and without them not a plant-house in the world could be carried on.

It is not surprising that the care of plants under glass should be a fascinating and delightful accomplishment for young girls and women, and also an interesting and profitable business for both men and women. There is nothing whatever to prevent any young man or young woman from becoming an observer, and learning to care for plants under glass. We have learned many important facts from our observations. It is the application of the results of these observations, that makes it quite possible for any one to soon learn the art of creating an artificial climate suitable to any flower or fruit. It is quite possible we may never wish to do this; but it must be kept in mind, that, in any case, we should know about these things, that we can have a right understanding of one of the ways by which wealth is taken out of the ground. We may never enter a plant-house except for pleasure; yet, when we do so, we do not wish to expose our ignorance of one of the most important industries in the country.

Thousands of highly educated men have given all their lives to the study of plants under glass. In England, hundreds of the most cultivated and charming young ladies work in or control fine greenhouses, and in no wise consider it beneath them to be thoroughly familiar with the care of plants under glass. If any girl, or girlish young man, thinks that such things are not exactly polite or "genteel," they should visit Eng-

land, and see the daughters of titled families skilful mistresses of the fine art of caring for a greenhouse. Perhaps they would see and hear some things that would make their ears tingle with mortification. The care of plants under glass is essentially a womanly and ladylike occupation, and many ladies have made themselves famous for the splendid products of their orchid-houses and conservatories. As a business, it is worthy of any man's attention; and, as a science, worth the spending of a life in work, experiment, observation, and study. Fortunes have been made under glass, and many a plant in our gardens bears the name of some celebrated greenhouse-man who found fame and fortune in his work.

The number of different plants now cultivated under glass is so great that it is found best to grow each in its own special climate. This has led to the use of special houses for special crops. In a few instances, two or more varieties of plants are placed together; and we find radishes growing in the same house with lettuce, and melons and cucumbers growing together, while geraniums, carnations, and roses, with perhaps other plants, are often seen in one house. The best growers, however, who raise plants on a large scale, prefer one house for one kind of plant at one time; and we find, near all large cities, houses devoted wholly to single flowers or crops like the carnation, violet, rose, lettuce, or cucumber. Knowing the precise amount of heat or water suited to each crop, the skilful gardener is able to adjust his artificial climate

exactly to the wants of the plants; and in this way he gets the best crops and the largest profit.

As a business, this work is divided into a number of branches. The first and most important of these is floriculture. This means the growing of plants for their flowers and ornamental foliage. As a business, it has, in the last few years, grown to enormous proportions, there being not less than a million dollars invested in the business in and around the city of New York. It is divided into two branches. The first of these is the growing of cut flowers and ornamental plants for decorating houses and churches; and the second is the growing of plants to be set out in the spring, in the kitchen and flower garden. It is also again divided into many minor branches, one man devoting his whole time to one or two kinds of plants. In such a case a man may be known as a rose-grower or violet-grower or lettuce-grower.

XXXV. **THE TWO ROSES.** — We may take one of these special branches of business, and see how much of knowledge and skill it requires, and how important it is that the man should be a trained observer. We will take, for example, rose-growing. A man in this business of growing roses for the market conducts almost the whole of his work in an artificial climate. First of all, he must understand the different varieties of roses. He must not only understand the difference between the full, deep-red Jacqueminot rose, and the long, slender, red, white, and yellow tea-roses, but he must know their habits, their modes of

sleep and rest, and, above all, the temperature and rainfall of their native climates. He must next build houses in which he can create an artificial climate exactly suited to each kind. Let us take first the tea-rose. The tea-rose, of which there are many varieties, belongs in a warm climate, where there are long summers and short, mild winters. In its native home the thermometer seldom fell below 32°, and there was no snow, and only a little frost. We feel sure that this must be so, because it will not survive even moderately cold weather; and in the Northern and Middle States it is destroyed if left out of doors through the winter. Planted out in the garden in May, it will grow and bloom till cut down by the frost. The plant, clinging to its native instincts, goes on blooming till the last, as if not knowing or fearing the winter, as if the summer would never end. The Jacqueminot plainly belongs in quite a different climate. Planted in the garden in the spring, it soon begins to grow rapidly, sending up short, sturdy shoots, and displaying its magnificent flowers in one splendid crop early in the summer. As soon as the flowers have faded, it prepares for the winter it seems to silently remember. Its sturdy stems stop growing in August; and like our hardy trees, the oak and maple, it begins to ripen its wood, and by October its leaves have fallen, and the bush sleeps safely through any moderate winter.

It is plain, that, to produce these roses out of season, two wholly different climates must be created.

One will have a long, warm summer and short, mild winter: the other must have a real winter, lasting at least three months, and then a spring, a summer, and a fall. In one there will be much warm rain: in the other there need not be so much rain, and even snow will do no harm. It is clear that the man who grows these two roses must be an observer. He must understand a thermometer and rain-gauge, and he must be a careful observer of the seasons. If he makes observations of the temperature at seven o'clock every morning, he will observe the glass falls below 32° in October, and that the tea-rose is dying or already dead, and that the Jacqueminot rose has lost its leaves and gone safely to sleep. In creating an artificial climate for one rose, he must never let the temperature fall below 45°: for the other rose, he should never let it rise above 40°, for many weeks. Let us see how he will do this. The rose-house for each plant may be, as far as the shape is concerned, exactly alike. The difference will be wholly in the way the climate is managed. We will suppose it is July. The tea-rose is planted in the border or bed in the rose-house; but as all the windows are wide open, or the top of the house has been taken off, the plant is practically out of doors, and it grows finely all summer. The other is growing in the garden, and stays there till its leaves fall in October or November. By the last of September the nights grow cool, and the glass is put on the rose-house, and it is closed at night to keep the plants warm. Now it is in a wholly artificial climate,

When cold weather comes, fires must be started, and kept up day and night. A thermometer hangs inside among the rose-bushes; and this is consulted every few hours, day and night, all winter long. Though the snow flies outside, the roses inside must be in perpetual summer. They are in a climate resembling that of their native country, and they bloom steadily from early fall till late in the spring. Then they are exhausted, and need rest. The summer out of doors has come again; and they would grow again rapidly, did they not need the winter rest they missed. Placed out in the garden, they will only rest, or grow in a listless way; so it is better to to kill them, throw them away, and begin over again with young, fresh plants. The hardy rose, on the other hand, has its winter and its rest. In November, before the ground freezes hard, the leafless plants are taken up and placed in pots, and put away in a dry cellar where the thermometer never rises above 40°, nor falls below 30°. Here they sleep, with very little water, till the earth in its orbit begins to bring back the spring. As soon as the sun begins to return from the south, say in January, the plants can be carried in their pots, and placed in a cool rose-house where the glass does not fall below 40° at night, nor rise above 70° by day. It now lives in an artificial climate exactly resembling April. If the rose-man observed the temperature through some April, he will know just how to manage his little climate for his roses. He knows that April is showery. He learned the amount of rainfall for that month, and gives his

plants just about the same amount of water. The dry stems of the bushes soon begin to change color, the buds swell, and the tender green leaves appear. The days go on, and he changes his climate to imitate May. He urges his fires and gives more water, makes it damper and warmer and more summery. As a reward, the splendid rosebuds appear; and, while the snow still flies out of doors, the great blooms fill his whole house with their delicious fragrance. When the summer returns, he must put the plants again in the garden, that they may ripen their wood and prepare for the next winter; or he may throw the plants away, and begin again with younger and fresher plants. As he put all the plants in the stationary climate of the cellar, he may bring a few at a time to the spring climate of his rose-house, and so have them grow and bloom in succession.

This study of these two roses shows the value of our observations. We have only to make these observations of the temperature, the wind, and the rain, and the seasons, to tell precisely the natural climate of any plant. Knowing this, we can imitate this climate, and cause any plant to grow and bloom out of the regular order of the seasons where we live. We can, under glass, force fruits and vegetables as well as flowers. Floriculture includes the growing of plants for their flowers or foliage, and also the growing of garden-plants. We observe the cabbage growing in a certain temperature, and we can imitate the climate in which the cabbage spends the first six weeks of its life. In

this way we can produce, even in a very small house, tens of thousands of cabbage-plants, and sell them in April to the farmer who wishes to set the plants out in his fields. This growing of plants in the spring forms the other great branch of the florist's business. The use of an artificial climate for producing strawberries, grapes, peaches, and other fruits, makes another important business. The growing of lettuce, radishes, cucumbers, and other vegetables, is still another, and a business that gives employment to hundreds of people near all our large cities. In all, the man or woman in the business must be a student and an observer.

CHAPTER VI.

CLIMATES AND PLANTS.

XXXVI. **THE TRAVELS OF THE SEASONS.** — Our observations of the motions of the planet on which we live show us that each year is divided into different portions, called the seasons. Our observations of the temperature have shown us that there is a continual rise in the temperature in the spring, and a continual fall in the autumn. This rise and fall is exceedingly irregular, yet a study of the diagrams we have made plainly shows that there is this rise and fall. In some parts of the country, as in Florida or California, or in some parts of the Dominion of Canada, there may seem to be variations in this advance of the heat in spring and this decline in the fall; yet it will be found true everywhere, that there is a rise as the days grow longer, and a corresponding fall when the shorter days return. In winter our seven-o'clock observations of the temperature will everywhere show variations, yet for many weeks it will remain generally cool or cold. In Georgia this time will be short; in Maryland, Kentucky, and Kansas, and other Middle States, it will be longer; in Canada it will be still longer. In summer there will be variations, but with generally very warm

weather; and the curious thing will be, that the time in which this state of affairs continues will be exactly reversed. In Canada it will be quite short; in Maryland and Kansas it will be longer; in Georgia and the Gulf States it will be still longer. If we could compare the observations made at the same hour in different States, we should find that there is, each year, a movement of warm weather up from the south over the whole continent, and in the fall a movement of cold weather down from the north. Plants are affected by the temperature in which they live. Each kind finds one particular climate best suited to its life and wants. We find the lily of the valley prefers a cool, damp climate: the cotton-plant must have a warm climate with a long summer. The wild strawberry and the blueberry thrive well in the cool, short summer of Maine and Canada: the orange-tree must have the long, warm summers and mild winters of Florida, or it will not live a year.

There was a time, centuries ago, when each variety of plants lived only in its native climate. For instance, the potato is cultivated in Europe; and yet there was a time, not long ago, when the only potato-plants in the world were in South America. The seeds or tubers of the wild potatoes were taken to Europe; and, finding there a climate like that of their home in Peru, they grew there quite as well as in their home. Did we not know of this, we might think, as no doubt many people in Europe do think, that the potato had flourished in Ireland ever since the world began. We

call it an Irish potato: and it is a good South American, and never grew in Ireland till it was carried there in a ship. All of our farm and garden plants have been moved about from one part of the world to another, till it is sometimes difficult to say where they came from; and, as a result, we may be in doubt as to their native climate. Within the past twenty years, this moving of plants from one part of the world to another has been carried on in the United States, upon a very large scale; and we find large crops of certain plants growing in States where, a few years ago, only a very few were ever seen. This matter is of the utmost importance, and we shall consider it again presently. In order to understand it clearly, we must first look over the whole country, and observe the wonderful procession of the plants and flowers through the seasons.

XXXVII. **THE GRASS-WAVE.**—For this purpose we will take first the grass. We may suppose it is February. The earth, in its great annual movement, is bringing the warm days again to the whole Union. In New England, and the States along the Lakes, the ground is covered with snow, which extends as far south as Virginia, and perhaps south of the Ohio. Then comes a strip of bare ground, perhaps a hundred miles wide, or even much wider in some places. In Southern Texas, there is a slender line of green grass extending irregularly across the country from east to west. In parts of the Gulf States, there may be patches of green wherever any grass can grow. A month later every thing has changed. The ragged edge of the cap

of snow that extends down from the north has moved up, and the wide stretch of bare ground has followed it. There are green things to be seen in Tennessee, Arkansas, and South Carolina, and perhaps a narrow fringe of grass in Kentucky. This edge of the snow is plainly moving backward, and the edge of the green grass is following it. By fitful, irregular advances and retreats, the snow moves onward, followed by the strip of bare ground and yellow fields; and as surely behind it follows the line of grass. By April the snow has disappeared, gone off into Canada. Connecticut, Southern New York, Ohio, Illinois, and States as far north, are already green; while the warm rains are falling on the brown sods under the trees in Maine. The green line sweeps on, crossing the Lakes and the St. Lawrence, and crowding the snow far up into Manitoba; and the whole Union is wrapped in green. Then comes a brief pause, and the snow returns from the arctic north. The grass shrinks before it; and the line of yellow, this time quite narrow, comes back, closely followed by the edge of the snow. So steadily does the snow advance, and cover all the land, that it seems as if it would never stop. By December it covers all the Middle States, and threatens to reach the Gulf. Advance guards of the white enemy even take possession of the mountains far down into Tennessee. Did nothing prevent, the snow and cold would move on and cover the West Indies, Mexico, Central America, and touch South America, and invade the tropic valley of the Amazon. About the twenty-first day of Decem-

ber, the planet turns again to the sun. The eternal winter has not yet come. There is to be a new spring and a new summer. It begins far south, beyond Cuba, and moves over the seas, to land first on the point of Florida and the coast of Texas. The emigrant spring has landed, and every plant in all the northern continent dreams of it in its wintry sleep. The snow may advance and retreat over the Carolinas and through Tennessee and Arkansas; yet it can go no farther, and must move up before the advancing sun and the breath of the south wind. The sleepy potato in the cellar, and all the plants in glass houses, know the spring is coming; and if in their artificial climate it is warm and damp, they will think it is spring, and begin to grow as soon as the holidays are over.

XXXVIII. **THE TRAVELLING STRAWBERRY-CROP.** — For another illustration we may take the strawberry. Fifty years ago the people in New-York City had strawberries to eat for about two weeks in June. They waited patiently till the gardeners brought them over from Long Island and New Jersey; and they ate as many as they could find, and were thankful. When the berries were gone, they said, "We will have some more next year." Now any one who can afford it can have strawberries from February till the middle of July; and, if you can pay a high price for a very few berries, you can have them nearly every day in the year. At first it might be thought that the early strawberries sold in New York, in March, were raised under glass. Some of the very choice and high-priced berries

are so cultivated. The market-gardener, being an observer, saw that the strawberry-plants had their winter of rest, followed by their spring for growing and early summer for blooming and fruitage. He wisely concluded that the plants would be just as well satisfied if they passed a shorter and milder winter in a cellar. So he induced the young plants to take root in the summer, in pots, and then in the fall stored them in a dry cellar. As soon as the sun began to return, he took the now dry and sleeping plants to the spring-like climate of his forcing-house, and gave them water. In a few days the tiny new leaves appeared, and, in due time, the flowers and the ripe fruit. Twenty years ago this was regarded as a good and profitable business. Many people wished the berries to give to sick friends, particularly to children, who could use the delicious fruit to disguise the taste of their medicines. Now, though strawberries are still forced for the market under glass, the business is reduced in extent and profit by the importation of fruit from the South. The strawberry is an early summer fruit; and it can be made to come into bearing, from Georgia to Maine, through every State in turn. The first berries received in New York come from Savannah. Then they arrive from Charleston and Wilmington. Next they come from Norfolk, and a little later from Delaware. Then the Garden State pours its immense crop over the Hudson River. The advancing line sweeps on up the Hudson, through New England, and on far into the Eastern Provinces. It is said that a certain per-

son who was very fond of strawberries once followed them up the coast. He had them for two weeks in Savannah, fresh from the vines. Then he found them running away from him; and he made a long jump to Washington, and got in ahead of the first Virginia berries. He dined upon berries here for two weeks, and then skipped over to New York right in the midst of the Long-Island crop. He had not to wait long before they were ripe in Boston. He hurried on after them, and had them fresh from Cambridge and Dorchester; and doubtless would have travelled bravely on to Canada, had not his physician decided that eight weeks of uninterrupted fresh strawberries were too much for mortal man, and forbade the further chase of the wandering strawberry-crop.

The experience of this unfortunate person is now common; and the curious thing is, that we needn't travel at all to have a taste of the whole long crop as it moves over the land. With the exception of a few choice crates of berries from some forcing-house, all the fruit brought into New-York City, before the natural season, is brought from the South. Later, when the native fruit is gone, and the red wave of berries has swept past, up the Hudson, another and a later crop travels backward from Boston, and perhaps from Halifax. This bringing of fruit from the South in the spring is an important matter; and we may consider it again, more in detail, presently. Just now we have to observe, that many of our garden-flowers, vegetables, and fruits move over the land in the same curi-

ous manner. First comes the green edge of the grass: later follows a red wave of strawberries. There is also a raspberry-wave, a cucumber-wave, and, no doubt, a dark-green wave of watermelons.

Certain flowers are much sought by bees, for the sake of the honey they contain. Very few flowers last in bloom more than two weeks; and, to permit the bees to be near particular flowers, barges loaded with beehives have been towed up the Mississippi River, stopping all along wherever that particular flower could be found. First they bloomed about New Orleans in the last of the winter, then in early spring higher up, and so on, till they bloomed at last in midsummer on the Ohio. The barge actually kept pace with a wave of flowers as it swept over the land.

XXXIX. **THE PLANTS AND THE SEASONS.** — If we observe the common flowers, vegetables, and fruits in any good garden in the Middle or New-England States, for one summer, we shall find that they can be easily classified into three groups. There will be the early spring plants or fruits, the midsummer fruits and flowers, and the late or fall flowers, fruits, or vegetables. The different crops will come in turn, forming a floral procession. Among flowers, there will be, first, the snowdrops, hyacinths, daisies, pansies, lily of the valley, and others. In summer will come the great host of flowers, — the roses, geraniums, heliotropes, sweet-peas, peonies, and many more. Later will come the asters, the dahlias, chrysanthemums, and tuberoses. In the kitchen-garden this is even more

marked. First, among the spring vegetables, come rhubarb, lettuce, radish, and asparagus. Then the summer crops follow: the peas, beans, sweet corn, and other things. Lastly come the fall vegetables, — tomatoes, melons, cucumbers, potatoes, and the root-crops, the beets and turnips. The garden-fruits form a steady procession right through the season. The strawberries, currants, raspberries, blackberries, grapes, and the pears and apples, form a continuous series from June to October.

On the farm, there is the same procession of the crops, — the hay-crop followed by the wheat-crop, and so on.

In the fields and woods we find the same thing: the wild strawberry ripe in June, the blueberry in August, the wild grape and the barberry ripe late in the fall. Among the wild flowers, there is the same procession of bloom, beginning with the arbutus, and ending with the fringed gentian and the wild aster, with all the great company of summer flowers between. There is, however, this difference between the wild fruits and flowers, and the cultivated plants. All the wild flowers in any place survive the whole year round, the plant or the seed sleeping or resting through the winter; while in the greater part of the country many of the garden-plants die in the winter, and would not appear again unless their seeds were gathered and saved till the next spring. All our cultivated plants were at one time wild. At least, we have every reason to think so; for we know that very many were

wild not many hundreds of years ago, and, of those whose history is lost, we can feel quite sure that there was a time when they were wild natives in some forgotten climate and country. We have observed that certain crops, like the strawberry, may ripen in succession, in different parts of the country in turn. We see the order of blooming and ripening at any one place may also be in succession; and these two things can be put together with a result that affects the price of food on every table in the country, and adds every year millions of dollars to the wealth of the country. To understand this, we will take a few plants, and look up their history and native climate, and see how they may be used in regard to artificial climates under glass, and the changing seasons as they move forward and backward over the country. If plants are a source of wealth, and are affected by seasons and climates, we can use our observations to decide what plants may be used to advantage in any particular place and any particular time. First of all, it is understood that we have learned from our observations the temperature, rainfall, and the general character of the winds, the storms, cloudy and pleasant weather, that form the climate of the particular place where we happen to live, and where we wish to gain money from the ground by cultivating plants.

XL. **SOME PLANT-HISTORIES.**—The common lettuce of our gardens is regarded, by good authorities, as a descendant of the wild lettuce called *latuca scariola*, and a native of temperate and Southern Europe,

Algeria, the Canary Isles, Abyssinia, and the temperate portions of Eastern Asia. In these countries the plant is found wild; and the climate of these countries ranges from that of Georgia to Virginia, and Arkansas to the middle of Indiana and Illinois. It will grow readily in this broad belt across the country. It will also grow everywhere from Southern Florida and Texas to the Eastern Provinces and Manitoba. It will not grow wild in Maine, and yet it is cultivated there. How is this explained? Let us look at the plant from a business point of view. We raise lettuce for salads, and use it on our tables when it is comparatively young. As soon as the leaves begin to gather, and form a head, we pull it up, cut off the root, and use the crisp, brittle leaves. If we do not pull it up, the leaves grow tough and unpalatable, and a flower-stem rises from the centre of the head; and in due time the flowers and seeds appear, and the plant dies. We observe that the whole value of the plant is in its youth. We must eat it when it is young, or in about eight weeks from the time the seeds are planted. We do not want the flowers or the seeds, and have no further use for the plant after it is eight weeks old. It is of no consequence whether it would be burned up by the long, hot summer of Florida, or nipped by early frosts in Northern Canada. All we want is the half-grown plant in the spring; and, as the whole crop is consumed as soon as it is old enough to eat, it is not of any consequence what the climate may be after that.

We have seen that an artificial climate resembling

spring can be made under glass, and we observed that the spring temperature moves up from the South on the land every year. It is therefore plain that lettuce is adapted to an artificial climate anywhere in the world, without regard to the weather outside the building where it grows. The ground may be covered with snow till May, as in parts of Canada; and yet, in a plant-house, lettuce can be grown there at any time after the season turns, on the twenty-first day of December. Besides this, as an artificial climate under glass is completely under control, we can have spring weather in the house for four months, and, by planting fresh seeds every few weeks, have a succession of lettuce-crops. This accounts for the fact that lettuce can be bought ready for the table, in Boston, from the middle of March to the first of July. The plants are raised in succession under glass, and then in succession out of doors; and, of the millions of plants that are raised round that great lettuce-centre, perhaps not one in one million ever goes to seed. No doubt there are hundreds of thousands of people in the Northern cities who eat lettuce every day, and never saw a single plant in bloom.

Now observe the advantage of our observations in regard to the temperature in April, May, and June. We may make a record of the temperature during the time the lettuce is growing, up to the time it is ready for the table; and, if we compare this with records at other places from Florida to Maine, we can find at some time a climate exactly suited to the life of the

young plant. In Florida it may be in January; in Maryland, in March; in Massachusetts, in May. The spring climate travels north; and, knowing this, we can plant lettuce in Florida while the snow flies in Massachusetts, and plant it in Massachusetts when it is so hot in Florida that the plants would run to seed and perish.

We may now briefly consider quite a different garden-plant, cultivated for its fruit in every market-garden throughout the country. This is the tomato (*lycopersicum esculentum*), a plant with a comparatively long life; that is, compared with the lettuce that is soon fit to eat, the tomato is ready to give its ripe fruit only after many weeks of growth. The tomato is of American origin, it being considered a native of Peru. It is essentially a tropical plant. It will not survive the slightest frost, and requires a very long summer to perfect its fruit. How, then, do we find it growing in every market-garden from Florida to Maine? By the aid of observation and study, we are able to bring this tropical plant to perfection in a cool, temperate climate. We extend its season of growing, by making the plant spend a part of its life in an artificial climate. The farther north we do this, the longer must be the time in which the plant stays under glass; the farther south, the less time it spends in the hot-bed, and the earlier it goes out in the garden. In like manner its life depends on the return of the cold in the fall. In Maine the plant is killed by the first of October; and sometimes the farmer's wife,

fearing a sharp night in September, hastily gathers all the fruit, both red and green, and takes it to the house, and the next day spreads the fruit in the sun to ripen. Sometimes in the fall every farmhouse in Northern New England has its pile of tomatoes ripening on the porch, while all the plants from which they came are dead in the fields. In Delaware, at the same time, the plants may still be growing finely; and the gardener may be gathering the fruit for a week or two after every plant in Maine is dead. Plainly, then, Delaware is a better State for the tomato-crop than Maine.

Another interesting example of this relation of plants to climates is the cotton-plant. It is a native of warm countries, and will not survive a frosty night. So we find it growing in the warm Southern States, where it can begin to grow early, and have plenty of time to perfect its flowers and seeds. If, like the lettuce, its branches were covered with the white lint in a few weeks from the time the seed was planted, it could be grown perfectly in New England, and could be cultivated under glass everywhere. The valuable part of the plant comes late, and so we find it only in those States where the summer is long.

785398

CHAPTER VII.

PLANTS, CLIMATES, AND BUSINESS.

XLI. **OUR GREAT FARM.** — We have learned that all wealth comes out of the ground. If the people of the United States are among the richest people of the world, it must be that they cultivate in the soil many valuable plants. Farming is the leading industry in the country, and it has to do with the raising of plants. Our observations have shown us that the life of a plant depends upon the light and heat of the sun, the motions of the earth, the movements of the winds, and the clouds. We have learned that the successful raising of plants depends upon climate, and that all climates must be studied by observation. He who never lifts his eyes above the soil on which he stands, who never looks beyond the little county in which he lives, may win from the ground something; but it will not be the best or the most profitable. The man or woman who observes, who looks abroad over the whole land, who sees all the wonderful products and varied climates of our country, learns what to do, and what not to do; learns what crops to plant, and when and how to do it; and wins success through study, observation, and right thinking.

The United States presents more chances for getting wealth than any single nation or country in the world. It extends entirely across one of the great continents, and covers the best of the great north temperate zone. In Alaska it touches the arctic regions, and in Florida comes close to tropic islands. The centre of the temperate climate passes through the centre of the country. Our largest cities are in the same climate as the largest cities of the world. We have in one country, and under one government, the greatest variety of climate, and, consequently, the greatest variety of plants; and, having these, we have the most varied sources of wealth. The mere recounting of our crops seems like a wonder-tale. Every State claims its special crop, and special source of wealth. New York shows its fine apples for sale on every fruit-stand in English streets. The Delaware peach-crop is the largest ever known in the history of the world. We have our own oranges from Florida, our foreign grapes from California. Our cotton-crop, our tobacco-crop, our crops of wheat and corn, are, compared to any thing ever known before in the history of the world, like fairy tales of wealth. As a people, we have more to eat than any human beings ever saw before. An American dining-room table contains a greater variety of food, and more of it, than was placed on any European table. Fruit is cheaper and more abundant, vegetables are in greater variety, than were ever dreamed of by Roman epicures, or prepared by the most extravagant French cooks. In London, pineapples are

often five dollars apiece: in New York you can buy a better one for five cents. Peaches in England are only for the rich: in our cities they are cheap on every street-corner. European peasants, Scotch and Irish laborers, and English mechanics hardly know what a good American farm-dinner means; and it is said that it takes the average emigrant two weeks to get accustomed to the good living of American housekeepers.

It is the same with all our crops, — our butter and cheese, our cattle, our cotton and tobacco, our hay-crop, even down to the annual crop of broiling-chickens, — marvellous abundance and apparently endless variety. We have a continent where we may choose a home: we can select almost any climate, — warm or cold, moist or dry, — and select the plants exactly suited to any climate. Moreover, we can have, in any large town or city, all the fruits and crops of every climate of this continent. If they do not grow in our neighborhood, they can either be raised under glass or be brought to us from distant States. The United States is, therefore, truly the greatest and the finest farm owned by any one nation in the world.

XLII. **PLANTS NATIVE TO ANY CLIMATE.** — We may suppose now that you wish to raise crops of some kind, either to sell, or for your own use and pleasure. We will take first flowers. You live in Massachusetts; and your observations show that the frost is not out of the ground much before the 10th of April, and the first nipping frosts in the fall appear about the first of October. So it seems your growing-

season out of doors is six months long. If you have no glass houses of any kind, your flower-garden will have only the hardy roses, the hardy herbaceous plants, and a few hardy annuals. It will be a good garden with a fair succession of flowers, but you will have none of the fine bedding-plants or foliage-plants. In order to have a really good garden, you must have a glass house of some kind, and raise these plants, or you must buy them of the florist. From October to May you will have no flowers at all, except under glass.

If you are living in Georgia, your garden may have nearly all the flowers seen in the Massachusetts garden, added to many more never seen in the North. There will be very little need of any greenhouse, and many plants that are killed by the early frosts in the North will live here all through the winter. Only a few plants will need to be protected under glass. In California it will be still different; and plants that will not, in New England, grow two feet high, will there climb over the tops of the houses, and give thousands of flowers, where, about Boston, they rarely produce two dozen in one summer. Every climate will have its own special charm, every garden its peculiar beauties. There will be little to choose between the gardens in any State in the Union; and, if glass is used, they will be all very much alike at some time in the year. Tea-roses will be seen in every garden; and the fuchsia, the azalea, the camellia, the gloxinia, orchids, roses, and carnations will be seen in every plant-house from one end of the Union to the other.

It is the same with fruits and vegetables, and with the farm-crops. In some States there will be hay-fields, in others cotton. In some States the marsh-lands yield cranberries, in others they are covered with rice. In the prairie States, the people will look after their cattle roaming over the half-wild lands: in other States, their time is all taken up with their great wheat-crops. The watermelon-crop is easily raised in the Carolinas, and only with difficulty in New Hampshire. Virginia is famous for its peanuts, Vermont for its maple sirup. Raisins come from California: the sharp and acid barberry grows wild in Massachusetts lanes. None of us can say that our home State has not its special crop for which it is celebrated. Every climate has its own flowers, its own fruits, vegetables, and farm-crops.

XLIII. **PLANTS AND BUSINESS.** — If plants are one of the means by which we win wealth from the ground, we must consider also another side of this matter. We can raise some lettuce, and put it on our table, and so make money by saving the money we might have paid to get the lettuce from some other place. All who live in small towns or in the suburbs of cities, and who have gardens about their houses, can do this, and should do this. Even though the amount may be small, still it is something; and fresh vegetables from our own garden are always more healthful than any we can buy in the markets, and therefore are worth more than the best in the market. All who are employed in business, and who have good ground about their homes, should use a part of their spare

time in cultivating either fruits, vegetables, or flowers.

This is, however, domestic economy, and, while it is business-like, is not real business. This means the raising of plants for the purpose of selling the crops in the market. We must consider this in regard to the climate of the particular place where we live, and in relation to our market, or the place where we must sell our crops. If we are living on a ranch in the Far West, it will hardly be worth while to cultivate a field of rhubarb or early lettuce; for there are not enough people living near to eat it. If we are living in Florida, it will be not very profitable to raise camellias in a greenhouse; for there are so many flowers out of doors that nobody cares to buy greenhouse-flowers. If you live in Portland, Me., it will hardly pay to plant cotton, or set out an orange-grove: your market may be excellent for cotton and oranges, but your climate will be against it.

There is also another matter affecting this question of crops. Steamships and railroads now enable us to move our crops quickly and cheaply from one part of the country to another. We may raise those plants suited to the climate of the particular place where we live, and send the fruit and other products to a distant market. This we see readily enough in the case of cotton, wheat, and other large crops. The wheat may be raised in Dakota, and sent to New York to be put on a steamship for Europe. Our cotton-crop is likewise moved to New England or Old England, and

there sold to the mills. We can raise grass in Connecticut, give it to our cows, and then sell the cows' milk in New-York City. We can raise grass in Illinois, turn it into cheese, and sell the cheese in Liverpool. We can raise roses in Newport, R.I., and sell the fresh buds in the streets of Boston and New York. All this is plain enough, and must be duly considered in selecting our plants; but within the past few years this matter has been carried still further, and we find the great cities of the Northern States supplied with early spring vegetables and fruits from the Southern States. Market-gardeners about New York, who used to take pride in having early vegetables for sale in the city, now find that the same vegetables arrive many weeks in advance of them, from Virginia and the Carolinas. These things appear to make the matter more complicated, and we may well wonder what is the best thing to do. If we have glass houses, and try to force early vegetables, we may find we cannot sell them so cheaply as the Carolina farmer, who raises them without the use of glass.

We need not, however, be perplexed. It is not such a difficult matter as it appears. First of all, the character of our climate settles what we can raise on one particular spot of ground. Secondly, the location of our place to markets both far and near must partly decide what we had better cultivate, to produce from the ground the most money. This is a matter we must each decide for himself or herself. Meantime we can observe that the best thing of any kind always

brings the best price and the greatest amount of money. Let us take a few of the more common plants, by way of illustration. You live near a large town, and have a piece of land suitable for strawberries. Your climate is like that of New England. Shall you try forcing strawberries, or, by means of shelter and early varieties, try to get them into market early? Your market is full of Southern strawberries just as your berries are ripe; and they are sold so cheap that your returns are small, and your land does not bring you so much money as you wish it might. Plainly there is a mistake somewhere. You should not try to have early strawberries, but late berries, ripe when the Southern berries have gone. Take the rear, and not the crest, of the strawberry-wave as it sweeps over the country. Moreover, as you are near the market, you can send them riper and in better condition, and in this way command a higher price, than the distant grower, who suffers from all the loss and injury resulting from the long journey. There is no need to despair, and say you cannot compete with the imported fruit. You must have better fruit, for it is always the best that brings the best price.

Your land is good for wheat, and you are near some Eastern city where certainly a great deal of wheat must be used to make flour. You try it, and find the land does not give you all the wealth it might. Wheat is raised so cheaply in Dakota that you cannot raise it without loss. Plainly your land must give you something that cannot be brought from Dakota. You must

produce those things that are needed in your city-market, and that are so frail or tender they cannot be carried long distances without injury. Potatoes will not do: they can be carried a thousand miles without harm. Flowers cannot be carried over two hundred miles. Very fine and choice vegetables, and flowers or choice fruits, are plainly the best things for such a farm. Your best plan will be to produce very choice plants, extra fine vegetables, superior fruit, and to command high prices by high-class crops. In other words, this matter of bringing crops from distant places, and disturbing the prices in our markets, plainly shows we must raise better plants, must become ourselves better observers, better and more scientific cultivators. While the world lasts, seed-time and harvest will not fail. The seasons will come, and plants will grow and bloom and bear their fruits, till our planet takes some new path, and the sun loses its fires. Wealth will always be found in the ground while there are plants to grow upon the land, and the seas remain to supply them with water. Our only plan is to observe, to watch and study, to keep acquainted with all that is done in our cities and markets and farms, and to read all good books that may teach us any thing of our work. Above all, we have to observe nature, and to learn for ourselves from the ever-open book of the fields, the sun, the clouds, and the winds.

XLIV. **EARLY AND LATE PLANTS, OR DOUBLE CROPS.** — We may now consider another matter in regard to plants and business. If our cli-

mate decides what we must plant on our land, it also gives us a chance to produce from the ground more crops than ever appear naturally in any climate. If we examine the wild plants, either flowers or fruit, we shall find that each plant, whether it be a buttercup in the fields or a wild blueberry-bush on the mountains, grows through the entire season, produces its one crop, and either dies, or sleeps through the winter. With cultivated plants, particularly those in the flower or vegetable garden, it is quite different. We collect, in one garden, plants from every climate; and we use some part of the plant for food or ornament, or for some other purpose, whenever it is fit to use, without regard to the life of the plant, whether it be long or short.

To illustrate, we can take our old friend the lettuce. We plant the seed early under glass; and, as soon as the head forms, we gather it and eat it. If we did not gather it, but left it to grow on naturally through all its life, we should soon find it sending up its flower-stem, blooming and perfecting its seeds. We do not want the plant for its flowers or seeds, so we pull it up for salad while it is still young. Suppose the seeds were sown in a cold-frame in March, and the plants set out of doors in the garden in May, and eaten the first week in June. As soon as the plants are pulled up, the ground they occupied is bare. It is too late to set out more plants; for, by the time they would be ready to be eaten, the days are so hot they would not grow well: still the summer is not half

gone, and we look about for another plant to take its place. We select the common white turnip. Here is a plant with a longer life. It grows from seed one year: the tops die down in winter, leaving the root; and, if the root is taken up and planted out the following spring, it will send up a stalk, bear flowers and seeds. But we do not want the flowers or seeds. The whole value of the plant to us is in the root, and we can leave the seed-raising to the seedsman. Moreover, we need not wait till the root is fully grown. We find it very good to eat when the plant is young, and before it has lived one-quarter part of its natural life. There will be time enough for turnips after we have eaten our lettuce; and, as soon as the lettuce is pulled up, we sow turnip-seed in the same ground, and let it grow till frosty nights come in October. Here we have upset the natural order in which these two plants will grow, and have produced from the same spot of ground two crops in one season. Plainly, we doubled the capacity of the ground for giving us money. We have, first, lettuce to sell, and then turnips to sell, in the same time that the wild turnip is growing one year in the fields. The natural life of the wild plant will be two years; but, by this changing of plants, we could get four crops in that time. We might plant early in the spring, pull and eat the turnips in July, plant again, and have more roots in October, and do this the next year, and so get four crops during the life of one turnip-plant.

This matter of arranging crops so as to get two,

and even three, in one year, or three in two years, is one of the most interesting branches of the science of farming. It applies to many of our vegetables and flowers, and to some of our farm-crops. It is the direct outcome of observation and study, and must be considered carefully by every one who expects to get any thing from the ground, either for food or for money or pleasure. We must lay it down as a rule, that, if the soil on which we stand is a bank from which we are to draw dividends in the shape of plants, we must not allow the bank to be idle for a day. As soon as the earth has given us one thing, we must at once make it give us something more. If we do not do this, but are idle and careless, the earth will go to work on its own account, and produce a fine crop of weeds worth nothing. The ground will not be idle, even if we are idle. It is for us to say what it shall produce.

In this matter of producing two or three crops in one year, or three crops in two years, observation must teach what plants to use. Find out first the extent of the season where you live. Observe your local climate. Then observe the plants best suited for your climate and your market. To help in the matter, a few groups of plants will indicate what, with a little skill and enterprise, may be done. Study the subject closely, and, whether you are raising plants for pleasure or for profit, be not content with a single crop of any thing in one year. There will be, of course, exceptions. Currants or raspberries planted

in the garden must stand year after year, producing one crop only; and that is all that can be done. However, to offset this, when once they are planted, they do not require re-planting for a number of years. The number of these crops, like field-corn, cotton, tomatoes, asparagus, fruits, etc., growing one crop a year, you can easily learn by observation.

To illustrate double-cropping, we can have two, or even three, sowings of lettuce, two sowings of peas, turnips, or beets, by gathering the roots early before fully mature. In regard to beets, the first crop may be only the tops of the young plants, used for table-greens; and, as soon as cut off or pulled up, a second sowing, or some other crop, may be put in. Peas, bush-beans, lettuce, or early carrots may be followed by potatoes, celery, turnips, or beets. We may set out strawberries after our peas or lettuce are gathered, and gather the berries next year in time to pull up the plants, and get in a crop of potatoes or something else. This will give us three crops in two years. There are many other groups of plants giving double crops. These you should find out for yourself, from observation. As soon as any crop from seed is ripe, pull up the plants, and clear the ground for something else. If the peas are gathered, why let the vines stand? We want the ground to give us more wealth; and it will not do so unless we treat it with respect, and show we know our business.

In flowers the same plan holds good. The hyacinths that bloom in April must give way to the pan-

sies and daisies; and, as soon as those are passed, they must be pulled up to make room for the bedding-plants. These, in turn, must be cleared off in time to put in our Dutch bulbs.

XLV. **CROPS IN SUCCESSION.** — Plants show another curious feature in regard to giving crops. If we plant a row of sweet peas for the sake of the beautiful flowers, which we wish to sell or to keep for our own pleasure, we shall find the vines giving what seems to be a bountiful and beautiful harvest. We may think the flowers look well on the vines, and suffer them to remain uncut. In a short time they disappear, and we find the vines loaded with peapods. Now the black peas may be very good for another year; but we are not after seeds, but flowers. To prevent the peas from coming, we cut off all the flowers as soon as they appear. The next day more appear, and we cut again. We do this every day, and we find the flowers keep coming. The more we cut off, the more there seems to remain to be cut, — a happy illustration of the fact, that, if we give away our flowers to friends, we shall have more for ourselves. The plants, being deprived of their flowers, at once produce new ones to take their place, and, if disappointed again, will keep on producing more and more till completely exhausted. This curious persistence in flowering after the blooms have been removed from a plant, appears in nearly all our common garden and greenhouse plants. The more they are cut, the more they bloom. Selfishness may keep all it can, and get little. Liberality is always profitable.

If we had a quarter of an acre of corn, and wished to have sweet corn for our table, we might plant the whole of the land at once, and in time get a fine crop. We may have sweet corn in plenty, more than we can use, and thus much of the crop will be wasted. This would be good gardening, but poor business. The better plan would be to sow one portion of the land at one time, and then, in a week or ten days, to sow more. Thus we shall find our sweet corn ripening for the table in two lots. One would be enough at one time, and thus all would be consumed without loss. When the first lot had passed, the second crop would come in. In this way the ground would yield us just as much as when the entire crop was ready at one time, and there would be no loss. This is business and gardening, and one must always go with the other. Science and observation are good, but we must guide our studies with the rein of plain common-sense. The same thing applies to many crops. We might plant our field with one crop of potatoes, and have them all ripe at once in the fall. They will keep all winter, and thus we can save and use them all. On the other hand, we shall have our crop at the very time when other crops are plentiful, and the price of potatoes is low. If we are using them on our own table, we shall not save — or, in other words, make — so much money as if we have potatoes when the price is higher. Plainly our best plan is to have two crops, — one small early crop when the price is high in summer, and one large or main crop for winter use. The

small early crop will carry us through the summer, when the price is high; and the larger crop can be preserved for winter use. In like manner we must consider our land in relation to the climates in regard to the preservation of our crops. Potatoes, turnips, beans, carrots, and beets can be gathered, and kept warm in a cellar all winter. Peas, lettuce, string-beans, and sweet corn cannot be saved, and must be eaten when ripe. There are exceptions, of course, as we can preserve corn, tomatoes, and fruit in cans and glass jars; but, for our own use, the best plan is to use these perishable plants when they are fresh and ripe. So we must consider, in planting, what proportions of each kind we may use. To plant so much lettuce, or so many rows of string-beans, that we cannot use them, would be wasteful of time, land, and labor, and the crops themselves. It would be wiser to have less of these and more of other things, like potatoes, that can be kept through the winter.

XLVI. **THE USEFUL PLANTS.** — We have considered the relations of climate to plants; we have made many observations of the sun, the winds, and rain, the days and seasons, in order to find how these things affect these sources of wealth; and we may, in conclusion, look at these plants themselves to see how they are to be used in business. Plants may be useful to us directly as food which we may use on our own table, and thus enable us to save money; or we can sell them for money, and use the money to buy other food, or any thing else we wish. It is ultimately the

same thing, and thus plants become the means whereby we win wealth from the ground. We will look first at the plants good for food. Of the many hundreds of plants growing wild in the different climates of the world, only a very few have been brought together from different parts of the world, and are cultivated in our gardens. Of these some have been known and used for thousands of years, so that no man can say when they grew wild in some ancient woods: others, on the other hand, are comparatively strangers in our gardens, and were growing in a wild state less than a hundred years ago. These plants are the standard food-plants; and all are suitable for gardens in at least one, and many of them in all, of the States of the Union: —

PLANTS HAVING UNDERGROUND PARTS USED FOR FOOD.

Radish, carrot, parsnep, beet, onion, Jerusalem artichoke, potato.

PLANTS CULTIVATED FOR THEIR STEMS OR LEAVES.

Cabbage, watercress, spinach, asparagus, dandelion, artichoke, lettuce, rhubarb.

PLANTS CULTIVATED FOR THEIR SEEDS.

Bean, pea, ground-nut, corn.

VEGETABLES CULTIVATED FOR THEIR FRUITS.

Squash, tomato, melon, cucumber.

Many of these are divided into several varieties; as, the squash includes the pumpkin, the cabbage the

cauliflower, the onion the leek, and so on. All these are vegetables raised from seed; and, with the exception of the dandelion, will not survive the winter in the Northern States. The asparagus and rhubarb are however perfectly hardy; and, once planted, remain, with care, in good condition, and give good crops for many years. Spinach will survive one winter, if protected, in the Middle States.

LIST OF STANDARD PLANTS, SHRUBS, VINES, AND TREES CULTIVATED FOR THEIR FRUIT.

Apple, cherry, peach, pear, plum, grape, quince, strawberry, raspberry, currant, gooseberry.

These are hardy in all the States (at least some varieties are); and in the South the pineapple, banana, and fig can be cultivated in a few places.

Next to these come the many varieties of nuts, nearly all being hardy. Then we come to the great staple farm-crops used for food,—wheat, buckwheat, rye, Indian corn, oats, and rice. Allied to these are those crops that furnish food to farm-animals,—the grasses, clover, corn, and oats.

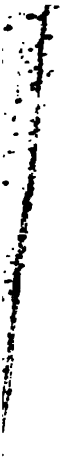
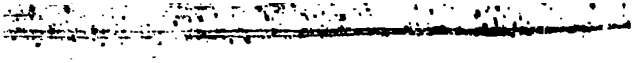
Next to these come those crops cultivated for their seeds, leaves, or other parts. These include tobacco, cotton, hops, flax, sugar-cane, and sugar-beets. These various plants used for food, or for fodder for cattle, or, like cotton, tobacco, and hops, useful in other ways, comprise the direct means whereby we may win wealth from the ground. There are many others used in various ways, and of less importance, as the sor-

ghum and the sugar-maple. These are the chief plants, and give us our great staple crops, upon which all the people of this country must depend for food, and upon which the larger part of the people must depend for a support. It is the care and culture of these plants that has created the larger part of the business of this country; just as their culture has made the chief industry of the world since men gave up being savages in the woods, and began to be men who observed and labored.

In a certain crude way, men have recognized that the growth and health of these plants in some way depended upon the sun, the rain, the clouds, and winds. During the thousands of years that some of these ancient plants have been cultivated, men have learned from long and most discouraging experience that these things affect for good or ill all plants. This experience led, in time, to the formation of certain rules for cultivating each kind of plant. These rules are generally wise, and can be followed safely. At the same time they are, many of them, wholly false and mistaken, because they are founded on imperfect observations. Many farmers observed, that, if the ground between the rows of potato-plants was stirred to break the crust formed over the surface after a rain, the plants grew larger, and produced more potatoes. They therefore came to the conclusion, that a plough drawn through the soil, and throwing the earth on each side against the plants, would help them. Did not the ploughshare disturb the soil deeply? If a shallow

stirring would help, then a very deep stirring would help more. Close and careful observation, a real study of the plant, would prove this might not be so. The plant is a living thing. It has roots extending through the soil in every direction, just beneath the surface. The plough, going deep under the soil, tears and breaks the tender roots of the plant, and does it more injury than all the benefit that comes from stirring the surface of the soil. Some one with more knowledge found, that, if the soil be merely raked over lightly, the plants grew just as well as, and in fact better than, if cultivated with a plough. Moreover, it was observed that the tender feeding-points of the roots were at the ends of the roots, and that the plough not only broke these off, but took the soil away from the place where it was needed, and put it against the stem, where it was not needed. Curious as this mistake is, there are every year thousands of acres of potatoes cultivated in the old way. Our observations would tell us that the chief object in lightly stirring the soil is to open it freely to the influence of heat, light, and moisture; in other words, to enable the plant to have all the benefits of the climate. Again, our observations must not lead us to a half-truth. We might find our rainfall so heavy, and our potato-field so wet, that this ploughing between the plants would serve to drain away the excess of water, and thus do less harm than would at first appear. In all things we must be guided by exact observation.

XLVII. **CONCLUSION.** — This single illustration

of the want of observation in the care of plants shows us that we have now reached a point in our studies, where the whole thing seems to widen out in many directions. We have seen that plants are one of the means whereby wealth is obtained from the ground; and we have seen that their well-being, and even life, is dependent on the weather. We become observers, and are prepared to cultivate plants in a scientific spirit. We now look wider over the field, and find there are many other things to be considered. A plant requires food as well as light, warmth, shelter, and rest. It lives in the soil, and a very little observation shows us that there are many kinds of soils. In some soils certain plants flourish, and return fine crops; while other plants in the same soil slowly perish, or return such small crops that the labor we spend in caring for the plants is all lost and wasted. A plant is a living thing; and yet, with a very few exceptions, all plants appear completely insensible. We can cut them with a knife, and they do not appear to suffer. On the other hand, some plants will bleed to death if cut with a knife. They do not seem to suffer any thing like pain, and yet they die. We find also that all plants have vital parts; and, if these parts be injured, the plant will die. Cut a ring round a tree through the bark, and its leaves soon wither, and in time the tree dies. Cut off all the roots of a plant, and it perishes. At the same time, a small portion of the top or the root of a plant may be cut off without injury to the rest of the plant; and the part cut

off may, under certain circumstances, grow, send out roots, and become a new plant exactly like the one from which it was taken. We are plainly entering upon a great field of study, full of the most interesting and curious subjects for observation and experiment. This study invites us to go on to see more and learn more. The great world of growing things — some very beautiful, some good and pleasant to the taste, others useful and valuable in many ways, and all, in greater or less degree, contributing to the wealth of all the people in the country — is well worthy our careful study. We have seen how much can be learned from careful observations of such common things as the wind, the rain, and the sun. We now come to the study of the plants themselves in their home, the soil which forms the surface of the planet on which we live. If plants are the means whereby we win wealth from the soil, it is plain we must go on, and by observation and experiment learn more about their lives, their habits of growing, and methods of continuing and multiplying their kind upon the earth. There is nothing difficult about these studies, nothing we cannot learn by observation and experiment. These two, observation and experiment, are the keys with which we can unlock the doors to any science. And in this spirit we will now go on to the second book of the required readings of the Chautauqua Town and Country Club. This second book of the series is to be called "TALKS ABOUT THE SOIL."